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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR.—HENRY CORDER.

REPORT OF THE SECTION, 1897.

Introductory.

The past year has been one of the most disappointing which this Section has experienced. The moon was near the full on the occasion of most of the principal showers, and cloudy weather also interfered to quite an unusual extent.

Fortunately it was clear at the time of the January Quadrantid shower, and some good observations were obtained; but the later showers were of feeble intensity, and the Leonids, of which great things were hoped, were scarcely observed at all.

Under these circumstances it is hardly worth while to print a list of Members of the Section as so little has been done, but it is to be hoped that during next autumn when the moon will be absent, the weather also may be propitious. However, the Director desires to thank all who have assisted in whatever could be done, and also to acknowledge Mr. W. F. Denning's kindness in furnishing the interesting details of a number of bright meteors, most of which were seen by some of our Members.

Bridgwater,
February 25, 1898.

HENRY CORDER,
Director.

Meteor Showers, 1897.

JANUARY QUADRANTIDS.

The first two or three nights of the year are not often the best for meteoric observation, and consequently this shower is seldom well observed. It seems also to be of short duration, and the maximum is soon passed. Fortunately it was fine on the last night, that of January 2nd, with clear intervals on other nights near that date, and some unusually good observations were thus secured.

Mr. Backhouse began his watch at midnight on December 30th, but no Quadrantids appeared, and only one in about a quarter of an hour just before daybreak the next night.

On January 1st Mr. Backhouse commenced watching in the evening twilight when one or two meteors appeared, and watches from a quarter to half-an-hour's duration were maintained at intervals all night, when a total of 97 meteors was secured. In the early morning hours, especially between $17^{h}0$ and $19^{h}0$ the rate of meteors was very high, almost up to one per minute. Nearly all of these were Quadrantids, and Mr. Backhouse computes that the zenithal horary number was as high as 64, about $17^{h}\ 15^{m}$. Of these 97 meteors 25 were considered to be of magnitude 0, five being equal to Sirius, and two rivaling Jupiter in brightness.

On the next two evenings in short watches only two meteors were seen. As this series of observations is one of the finest ever made of this shower, Mr. Backhouse's complete table is appended.

Watch for Meteors of the Quadrantid Shower.

By T. W. Backhouse.

Chiefly at Sunderland.

Explanation of Contents of Columns in Tables.

Time—beginning and ending of each look out; O—the number of minutes of observation in the interval; Sky—the proportion of clear sky in the direction of observation; O^1—the minutes of observation corrected for cloud; Hindrance—the other hindrances to visibility of meteors; Mag. vis.—the magnitude of the faintest stars visible in spite of these hindrances; F—the number of falling stars seen; R—their rate per hour; Q—the number of Quadrantids; Alt.—the altitude of the radiant point at middle time; $O^2 = O^1 \times$ sine alt.; and Q^1 is the rate per hour of Q upon O^2, or the zenithal horary number of Q, only that meteors whose directions were unknown have been counted as Quadrantids in the column headed Q^1, and are added in that headed Q.

Date and Time.	O.	Sky	O^1.	Hindrance.	Mag. vis.	F.	R.	Q.	Alt.	O^2.	Q^1.
1896, Dec. 30:											
h m h m											
11.58 to 12.21	10	·7	7	——	—	2	17	—	22°	2·6	—
12.35 „ 12.50	5	·4	2	——	—	0	—	—	24½	0·8	—
17.36 „ 17.38	2	·4	1	——	—	0	—	—	60½	0·9	—
Total -	17	—	10	——	—	2	12·0	0	—	4·3	—
1896, Dec. 31:											
10.38 to 10.52	12	·9	11	——	—	0	—	—	16	3·0	—
14.20	2	1·	2	——	—	0	—	—	35	1·1	—
18.7 to 18.29	17	1·	17	——	—	1	4	1	66½	15·6	3·8
Total -	31	—	30	——	—	1	2·0	1	—	19·7	3·0

Date and Time.	O.	Sky	O^1.	Hindrance.	Mag. vis.	F.	R.	Q.	Alt.	O^2.	Q^1.
1897, Jan. 1:									°		
h m h m 4.54 to 5.20	18	1·	18	Very bright twilight.	—	2	7	1+1	24	7·3	6·4
5.20 „ 5.30	9	1·	9	Bright twilight -	—	0	—	—	23	3·5	—
5.56 „ 7.2	20	1·	20	—	—	1	3	1	18	6·2	9·7
9.0 „ 10.28	25	1·	25	—	—	2	5	2	14	6·1	9·7
11.0 „ 12.4	26	1·	26	—	—	3	7	1	19	8·4	7·1
12.20 „ 12.56	26	1·	26	—	—	7	16	5	24½	10·8	27·8
13.13 „ 13.53	17	1·	17	—	—	4	14	3	29½	8·4	21·4
15.20 „ 16.30	20	1·	20	—	—	6	18	6	46	14·4	25·0
16.31 „ 17.7	18½	1·	18½	—	—	17	55	15+1	54	15·0	64·0
17.8½ „ 17.33	18	1·	18	—	—	13	43	13	58½	15·3	51·0
17.35½ „ 18.11	31	1·	31	—	—	23	45	19+1	62½	27·5	43·7
18.14 „ 18.40	21	1·	21	—	—	17	49	15	67½	19·4	46·4
18.43½ „ 18.49	5½	1·	5½	Twilight - -	5¾	2	22	2	71	5·2	23·1
Total -	255	—	255	—	—	97	22·8	83+3	—	147·5	35·0
1897, Jan. 2:											
6.10 to 6.24	7	1·	7	—	—	0	—	—	19	2·3	—
6.24 „ 6.28	4	1·	4	Town-light -	—	0	—	—	18	1·2	—
Between Sunderland and Stockton: 6.40 to 7.21	6	1·	6	—	—	1	10	1	16	1·7	35·3
Total -	17	—	17	—	—	1	3·5	1	—	5·2	11·5
At Stockton, 1897, Jan. 3: 8.15 to 8.45	11	·9	11	—	—	0	—	—	14	2·7	—
8.55 „ 9.15	7	·9	6	Thin cloud -	—	0	—	—	14	1·5	—
Total -	18	—	17	—	—	0	0	—	—	4·2	—
Grand Total	338	—	329	—	—	101	18·4	84+4	—	180·9	29·2

At Bridgwater the Director watched for an hour in the early evening, but only five meteors were seen. Another engagement prevented further observation until 10.30, and then only two were seen in a few short watches. One of these was a fine one in the S., magnitude 0, orange in colour, with a lasting streak. At 11.20 watching was commenced in earnest, and kept up almost without a break until 16.40, though fog came on for a time after midnight, but fortunately cleared off again. About six hours were fairly clear, and 130 meteors were seen, of which 109 were Quadrantids. Of these only two were reckoned equal to Jupiter, and they merely left faint streaks, being very different from the Leonids and Perseids in this respect, a very small proportion

having any train or streak. In only four was any colour noted, and these were orange and yellow. Either Mr. Backhouse had better fortune in seeing bright meteors, or, what is possible, the Director may be over cautious in the matter of magnitude, but the following figures show a small proportion above 1st magnitude. The second figure indicates the number of streaks in each group.

Mag.	>1.	1.	2.	3.	4.	5.	Coloured.
No.	3·3	11·4	22·6	50·3	18·0	5·0	4

The radiant was very diffuse. In some years the finest and longest meteors have seemed to come from a point in Hercules. This time it was scarcely recognised, or perhaps the area of the Quadrantids included the Herculid shower. They may be really connected, but the lasting streaks sometimes seen are generally from Herculids. The radiant area was, perhaps, triangular, measuring 10° or 15° along each side. The centre was at about 230° + 51°, but the most distinct positions were—

Quadrans	224 + 49
Draco	235 + 55
Hercules	234 + 49

The following table shows the hourly number of the meteors as observed, without any allowance for fog or loss of time.

Hour.	——	No. of Meteors.	Quadrantids.
h m h m			
6 30 to 7 30	—	5	3
10 30 „ 11 20	Intervals	2	2
11 20 „ 12 20	Clear	14	10
12 20 „ 13 20	Foggy	14	10
13 20 „ 14 15	15m lost through fog.	12	8
14 15 „ 15 15	Fairly clear	32	30
15 15 „ 16 15	Clear	39	34
16 15 „ 16 40	Foggy at end	12	12
About six hours clear.		133	109

It will be seen by comparing the above with Mr. Backhouse's table that the best of the shower was lost at Bridgwater by fog coming on at 16h 30m.

The subsequent nights were almost overcast, and no more were seen.

Prof. A. S. Herschel watched at Slough for the hour before midnight and saw seven meteors, of which four were Quadrantids. Radiant reckoned at 235° + 57°.

Mr. J. A. Hardcastle watched for about an hour after dark, and saw six meteors, all Quadrantids, and again for about two hours preceding midnight, when 12 more were seen, eight being Quadrantids. Two radiants were determined at 224° + 52° and 235° + 57°, agreeing fairly with those seen at Bridgwater. One, at 11.22, was rated as equal to Sirius or Jupiter.

Very few other meteors were seen by any of the Section in January; the chief shower at the end of the month was one of seven meteors from δ Cancri.

FEBRUARY.

Mr. Besley obtained a few good observations at the end of the month, and found a radiant of Coronids (five meteors) at $227\frac{1}{2}° + 27°$. It is probable that there are at least two distinct showers in this constellation in the spring, but this position agrees very nearly with the May shower.

MARCH.

Cloudy, and very few meteors seen. A few of the long Virginids from $199° - 10°$ were mapped at the end of the month.

APRIL.

Almost a complete failure this year, and no Leonids seen.

MAY.

A watch kept for Aquarids, but only two seen, one was a very fine one of great length. There was also a shower of star-like meteors from β Libræ ($232° - 9°$).

In June nothing was done, and in July little was seen until the end of the month, when a few Aquarids were noted, but it is evident that this shower has quite dwindled away. A few early Perseids were also mapped, and a few from near θ Aquilæ.

AUGUST.

It will not be worth while to write a detailed account of the Perseid shower, as it was not well observed, owing to the moonlight and cloudy weather. It would not appear, however, to have been a brilliant shower, for when opportunities did occur very few were visible. A list of radiants is given in the general table, showing a marked eastward movement from the end of July until the middle of August.

On August 3rd Mr. Besley was watching from 10^h until 15^h, and saw 27 meteors, of which only six were Perseids.

August 9th was the only really good chance, and Mr. Besley recorded 109 meteors between $9^h\ 53^m$ and $15^h\ 19^m$, of which 49 were in one hour (14^h–15^h). Of the total, 72 were Perseids with a radiant at $45° + 57°$. There was also a well marked shower of swift meteors from Taurus, seven in all, from $52\frac{1}{2}° + 15°$, and minor showers in Camelus and Lacerta. At Bridgwater it was not so clear, but the Director watched from $13^h\ 20^m$ to $15^h\ 20^m$, and counted 47 meteors with an hourly number of Perseids of 17 and 19. The radiant was well defined at $45° + 57°$, which agrees well with Mr. Besley's.

August 10th was very overcast, and the 11th partly so, and also there was a bright moon. Several watched for short intervals, but meteors were very scarce, only four meteors being seen between 10.30 and 11.30. Ten Cassiopeids were seen from $16° + 56°$, but they were of insignificant appearance, and possibly do not represent the strong shower of 20 years or so ago.

SEPTEMBER.

A few watches kept, but not many meteors were seen. The Piscids had commenced feebly towards the end.

OCTOBER.

The commencement of the Orionid period was cloudy and moonlight, but matters improved later, and a few good observations were made.

The first Orionid seems to have been recorded in an evening watch on October 19, at Bridgwater, when eight meteors were seen in about an hour.

October 20 was clear, and Mr. Besley watched between $10^h\ 30^m$ and $13^h\ 15^m$, but only saw 10 meteors, of which four were Orionids. At Bridgwater an evening watch of an hour's duration only produced seven meteors, none of them Orionids, so it was decided to wait until the morning, when 27 more meteors were seen, of which 14 were from the combined radiants in Orion and the feet of Gemini. It is not easy to decide as to whether these are truly separate showers, but it is possible that they are so, as the Orion radiant is always extremely well defined and stationary, and generally somewhat earlier in action. The Geminid showers, on the contrary, are several in number, stretching in a vertical line over eight or ten degrees. It is not easy to separate the meteors, so they are all classed together in the following tables.

Date.	Time.	Total.	Orion-Geminids.
	h m h m		
October 20 - -	9 0—10 15	7	0
,, - -	14 25—15 30	11	4
,, - -	15 30—16 30	9	6
,, - -	16 30—17 30	7	4
		34	14

On October 21 Mr. Besley watched from 11^h to $12^h\ 15^m$, but only saw four meteors. At Bridgwater 37 meteors were counted.

Date.	Time.	Total.	Orion-Geminids.
	h m h m		
October 21 - -	10 30—11 30	3	1
,, - -	11 30—12 30	9	2
,, - -	12 30—13 30	11	5
,, - -	13 30—14 30	14	3
		37	11

So it will be seen that there was not a strong display. On each morning a meteor as bright as Sirius appeared. That at $13^h\ 6^m$ on the 21st was orange with a green streak.

Most of Mr. Besley's meteors, which belonged to the combined showers, were true Orionids from $91° + 15\frac{1}{2}°$, but at Bridgwater most were Geminids chiefly from near γ at $96° + 18°$.

On October 28 another watch was kept, and 37 meteors seen in four hours. It was hoped that the Arietids would have appeared, but only about five were seen, even including Taurids. Most of the rest were very sporadic, with no marked radiant.

On October 29 Mr. Besley watched for an hour and a half, but only saw nine meteors. A few were Taurids.

NOVEMBER.

Reports were received from a number of Members of the Section and others, concerning the Leonids, but owing to the moonlight and bad weather it was only a record of failure, more or less complete.

Some patient observers sat watching a perfectly blank sky, others a dazzling moon, but none of them saw anything which could be called a shower of meteors at any rate.

Mr. Besley, in London, was the most successful, for he saw 27 meteors on November 13, $12^h\ 43^m$—$17^h\ 52^m$, of which 21 were Leonids with a very well defined radiant at $149° + 23°$. Of these, one at $15^h\ 53^m$ was equal $1\mathcal{U}$, and another two minutes earlier was rated at 1st magnitude, and left a conspicuous green streak. Mr. J. H. Bridger watched at Farnborough, and saw nine meteors, several of which were Leonids.

Miss Orr, at Camberley, saw four meteors, but perhaps only two were Leonids. No others of our Members report anything worth recording, but some people in Scotland appear to have seen a brisk shower before sunrise on November 15.

No Andromedes were seen, and the Taurid shower was not at all a strong one.

The chief watch kept at Bridgwater was on November 3, from $13^h\ 15^m$ until about 17^h, and 50 meteors were seen, but there was no very marked radiation.

During the month 13 Taurids were seen from about $59° + 24°$, the radiation not being so distinct as in recent years. There were in all 11 Arietids from $43° + 15°$.

DECEMBER.

Bright moonlight interfered with the Geminids and very few were seen. As these meteors are generally very small and short, they are easily lost on a light sky. Mr. Bridger saw three Geminids on December 10 in five minutes, but no others in an hour, and one was seen on the 12th.

At Bridgwater four only were seen, though observations were attempted on December 10th, 11th, and 12th.

Radiants of Meteor Showers, 1897.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1897.		° °			
714	Jan. 1–2	Quadrantids	224 + 52	4	Swift	J. A. H.
715	„ 1–2	„	224 + 52	4	Swift	A. S. H.
716	„ 1–2	„	235 + 57	—	Swift	J. A. H.; A. S. H.
717	„ 1–2	„	224 + 49	109	Swift	H. C.
718	„ 1–2	„	234 + 49			
719	„ 1·2	„	235 + 55			
720	„ 1–2	Leo Minor	133 + 33	3	Quick	A. S. H.
721	„ 23–24	δ Cancri	126 + 19	7	Quick	H. C.
722	„ 23–24	Monoceros	109 + 1	3	Quick	H. C.
723	„ 23–24	„	95 + 4	2	Quick	W. E. B.
724	„ 23–24	Hydra	139 + 5	3	Quick	W. E. B.
725	Feb.	Auriga	90 + 38	4	Quick	W. E. B.
726	„	Leo	150 + 9½	3	Quick	W. E. B.
727	„	Ursa	147 + 45	3	Quick	W. E. B.
728	„	Corona	227½ + 27	5	Quick	W. E. B.
729	Mar.	Canes V.	187 + 35	4	Quick	H. C.
730	Mar.–Apr.	α Virginids	199 − 10	6	Slow	H. C.
731	Apr.	Arcturids	211 + 21	3	Slow	H. C.
732	Apr.–May	Polarids	225 + 86	4	Quick	E. R. B.
733	„ „	Quadrantids	214 + 50	5	Quick	E. R. B.
734	„ „	Serpentids	230 + 16	4	Slow	E. R. B.
735	May 3	β Librids	232 − 9	6	Slow	H. C.
736	July–Aug.	θ Aquilids	300 − 5	5	Slow	H. C.
737	„ „	Equuleus	312 ± 0	3	Quick	H. C.
738	„ „	ζ Cygni	318 + 28	4	Quick	H. C.
739	„ „	Equuleus	311 + 3	3	Swift	H. C.
740	„ „	Lacerta	330 + 50	3	Quick	H. C.
741	„ „	„	340 + 50	5	Quick	W. E. B.
742	„ „	Camelus	80 + 80	3	Quick	H. C.
743	„ „	α Aurigæ	78 + 52	3	Swift	W. E. B.
744	„ „	o Piscium	22 + 11	3	Swift	W. E. B.
745	„ „	Cepheus	344 + 55	4	Quick	W. E. B.
746	July 25	Perseids	22 + 52	4	Swift	H. C.
747	„ 30	„	37 + 53	4	Swift	H. C.
748	Aug. 1	„	30 + 56	4	Swift	E. R. B.
749	„ 3	„	32½ + 57½	6	Swift	W. E. B.
750	„ 9	„	45 + 56	16	Swift	W. E. B.
751	„ 9	„	45 + 57	30	Swift	H. C.
752	„ 3	γ Andromedæ	22½ + 42	8	Swift	W. E. B.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1897.		° °			
753	Aug. 3	ζ Persei	56 + 31	3	Swift	W. E. B.
754	„ 2	Cassiopeia	39 + 65	3	Swift	W. E. B.
755	„ 2	Triangulum	27 + 35	3	Quick	W. E. B.
756	„ 2	Cassiopeia	16 + 56	10	Quick	H. C.
757	„ -	η Aquarii	338 + 3	3	Slow	H. C.
758	„ 2-9	λ Piscium	354 + 1	3	Slow	H. C.
759	„ -	τ Ceti	20 − 15	3	Swift	H. C.
760	„ 9	Taurus	52½ + 15	7	Swift	W. E. B.
761	„ 9	Camelus	72½ + 67½	5	Swift	W. E. B.
762	Sept.	γ Pegasi	8 + 16	3	Slow	H. C.
763	Sept.-Oct.	η-θ Ceti	19 − 11	3	Slow	H. C.
764	„ „	Lynx	123 + 34	4	Swift	H. C.
765	„ „	β Tauri	82 + 32	3	Swift	H. C.
766	„ „	θ Ursæ	135 + 63	5	Quick	H. C.
767	„ „	Custos	35 + 71	5	Quick	H. C.
768	„ „	Piscids	359 + 3	4	Slow	H. C.
769	Oct. -	„	354 ± 0	5	Slow	H. C.
770	„ -	Cetids	30 + 10	4	Slow	H. C.
771	„ 19-21	Orionids	91 + 15½	9	Swift	W. E. B.
772	„ 19-21	„	94 + 14	5	Swift	H. C.
773	„ 19-21	γ Geminids	96 + 18	20	Swift	H. C.
774	„ 19-21	„	100 + 19			
775	„ 19-21	ξ Geminorum	97 + 13			
776	„ 19-21	μ Geminorum	96 + 22			
777	„ -	α Arietids	27 + 23	4	Slow	H. C.
778	„ -	Cepheids	300 + 55	6	Slow	H. C.
779	„ -	ι Aurigæ	74 + 31	7	Quick	H. C.
780	„ 28	ζ Tauri	86 + 26	6	Swift	H. C.
781	„ 28	ζ Geminorum	106 + 22	4	Swift	H. C.
782	Oct.-Nov.	ι Ursæ	132 + 48	3	Quick	H. C.
783	„ „	Arietids	43 + 15	11	Slow	H. C.
784	Nov.	Taurids	59 + 24	13	Slow	H. C.
785	Oct.-Nov.	„	61 + 23	3	Slow	W. E. B.
786	„ „	Taurus	75 + 15	3	Slow	W. E. B.
787	Nov.	Leonids	149 + 23	21	Swift	W. E. B.
788	„	Canes Venat	201 + 44	4	Swift	W. E. B.
789	Nov.-Dec.	Telescopium	96 + 42	6	Quick	H. C.

Observers.—E. R. B. BLAKELEY. H. C. CORDER.
T. W. B. BACKHOUSE. J. A. H. HARDCASTLE.
W. E. B. BESLEY. A. S. H. HERSCHEL.

BRIGHT METEORS OBSERVED DURING 1897.

Date.	Time.	Mag.	Remarks.
1897. Jan. 1 -	h m 10 47	>1	From 115° + 5° to between α-β Canis Majoris, orange with green streak. Quadrantid.—H. C.
„ 1 -	13 43	4	From 20° + 70° to 34° + 54°. Faint streak. Quadrantid.—H. C.
„ 1 -	15 35	4	From 84° + 52° to 79° + 41°. Streak. Quadrantid.—H. C.
„ 8 -	7 20 Malta time.	♀	From 3h. 20m. + 40° to near β Ceti. Very slow. Red and blue, with spark train. REV. T. H. FOULKES, Malta.
„ 23 -	7 23	♂	Orange. Slow, with trains and sparks.—H. C.
Apr. 22 -	10 24	>1-4	Very slow. 7 secs. Blue at first, flashed out red at last. Disintegrated into sparks.—E. R. B.
„ 30 -	9 37	5×♀	From 166° + 51° to 156° 35°. Radiant. 291° + 59°.—W. F. DENNING.
May 5 -	10 1	>1	From 234° + 15° to 214° + 19°. Slowish. 2 secs. Golden yellow. Slight train.—G. F. DAVIS.
„ 5 -	12 32	> Vega	From 16h. 30m. + 43° to 19h. 13m. + 64. Greenish train, 5° long.—H. R. MAYNARD.
July 10 -	11 30	♂	Near α Ophiuchi, bursting into fragments.—C. WHYTE, Dunrossness, Shetland.
„ 14 -	11 10½	>♂	From about 2° S.W. of γ Pegasi, passed 5° above α and went 5° further. 2½ secs.—REV. S. J. JOHNSON.
„ 25 -	10 20	4	From 177° + 26° to 168° + 24°. Green, with orange train. Radiant, η Aquilæ?—H. C.
„ 29 -	7 0	☾	Fell from a few degrees E. of zenith to near E. horizon Pear-shaped, size of moon; in sunshire. — Per G. F. D.
Aug. 2 -	13 50	Sirius	From 9° + 25° to 342° + 65°. Streak.—H. C.
„ 2 -	13 87½	♀	From 310° + 33° to 309° + 49°. Breaking out with greenish flashes and leaving a knotted streak.—H. C.
„ 4 -	10 30	♀	Directed from ⅝° (α, δ) Ursæ Minoris, passed ½° E. of κ Cephei. Course about 12°. Brightening. Red train.—T. W. BACKHOUSE, Scarbro'.
„ 11 -	10 4	4	From 7° E. of α Ursæ Majoris, crossed that star, vanished half way to γ.—REV. S. J. J.
„ 11 -	10 8	♀	From δ Cassiopeiæ, passed ¼° beneath E., went on 15° to W.—REV. S. J. J.
„ 17 -	9 4	Sirius	Directed from Polaris, passed ¼° (δ, γ) Ursæ Majoris, disappearing behind house 10° further.—T. W. B., Sunderland.
Sept. 21 -	7 22	>1	Falling down line joining γ Cassiopeiæ and Capella. First seen half way between and ending near Capella. Distinct train.—J. R. FOTHERINGHAM, Sigglesthorne, Hull.
„ 27 -	9 40	♀	Lasting streak.—H. C.
Oct. 2 -	7 48	Sirius	From 282° + 33° to 231° + 26°. Slow. Bluish. Red train. Piscid. Long path.—H. C.
„ 20 -	12 20½	>1	From 71° + 15° to 58½° + 15°. Swift. Streak. White.—W. E. B.
Nov. 13 -	15 53	4	From 163½° + 12° to 177½° − 0½°. Streak. Leonid.—W. E. B.

Date.	Time.	Mag.	Remarks.
1897.	h m		
Nov. 18 -	5 30	>♀	From 322° + 8° to 326° − 6°. Rapidly increasing in brightness.—D. R. F.
„ 28 -	8 18	> 1	From 230° + 69° to 243° + 63°. J. E. CLARK, Croydon.
Dec. 1 -	5 15	♀	Brilliant white, near α Piscium, fell about 10° S. of that star, bursting into fragments.—C. WHITE.
„ 12 -	± 7 10	Sirius	Low down in Aquarius, a small green fireball with short train. ? β Taurid.—H. C.
„ 12 -	20 30	☾	Seen in daylight in E.N.E., moving S. Path about 20° in length. Greenish blue, with train of sparks and flame breaking from it.—J. T. POPE, Dingwall.

Doubly Observed Meteors, &c., 1897.

QUADRANTID = 𝔔 OF JANUARY 1ST, 1897.

The following double observation of a Quadrantid by Prof. A. S. Herschel and Mr. J. A. Hardcastle at 11·22, January 1st, is interesting on account of the nearness of the two observers to each other. As before shown, this makes the result less reliable, but as a lesson in working out the true paths of meteors it is worth giving in Prof. Herschel's own words. "The base-line "from Basingstoke to Slough is only 27 miles; but the two "mapped tracks of the bright Quadrantid at 11.21½ or 11.22 were "in excellent parallax agreement, giving a real path from 68 miles "over 2 miles E. of East Grinstead, to 42 miles over 5 miles S.S.W. "from Worthing; sloping path 42 miles in 2½ seconds, velocity "17 miles per second from a radiant at 190° or 200° + 62°, then "at altitude 39°, 32° E. from N., whose remoteness from the "Quadrantid radiant is not dependable, because both the tracks' "backward prolongations pass (on opposite sides) within two or "three degrees from 235° + 57°, but being very little divided "from each other by parallax, they happen to intersect (at a very "acute angle) a good many degrees before reaching that point; and "a lateral correction of less than a degree to either the end or "the beginning point of both the observations would make the "tracks prolonged backward intersect at 235° + 57°, instead of "at about 195° + 62°. The altitude of the radiant or slope of "path would be lowered then from 39° to about 20°, and if the "small corrections were made to the end points, the end height "would be raised from 42 to about 50 miles or more, and the "point of disappearance would become more distant from the "fixed beginning point and from Slough and Basingstoke than "before, and the length of path and velocity would be largely "increased, and the latter would no longer fall so short then, as "it appears to do at present (17 miles per second), of the real "meteor speed (25 miles per second) of the Quadrantids with "their radiant point at 235 + 57."

METEOR OF FEBRUARY 18th, 1897.

The Rev. T. H. Foulkes writes from Malta:—"Last night ± "6.17 p.m., Malta time, 58m fast of G.M.T., one of the grandest "and finest meteors I ever saw. It started about midway "between Castor and Capella, and moved very slowly in a N.W. "direction. There were no stars visible to enable me to give a "better course. The shape was pearlike, the base (*f* end) was a "lovely glowing orange-red, such as I have never seen before; "the head was intensely white. Little train. If it had been "dark the whole place would have been lighted up by this "brilliant object. The size I cannot estimate; quite four times "as bright as Venus is now."

METEOR OF APRIL 30th, 1897.

Mr. Charles Upton writes from Tower House, Stroud:—"An "extraordinarily fine meteor was observed here on April 30th, at "about 9h 38m. The meteor first became visible near η Ursæ "Majoris, passed near to γ Leonis, and eventually died out on the "confines of Hydra. The colour of the meteor was an intense "bluish white, like an arc light very much elongated, and it left "a trail of light for a considerable distance behind it, lasting two "or three seconds. The brilliancy of the meteor was so great "that the place was lit up almost as by a flash of lightning." As will be seen from Mr. Denning's table, this meteor was a Draconid with a path of 70 miles, varying from 59 to 18 miles above the earth, with a velocity of 23 miles per second.

METEORS OF AUGUST 18th, 1897.

The Rev. T. H. Foulkes, at Malta, saw two curious meteors on this evening. The first, at 7.55 Malta time, was in Aquila, moving very slowly from 19h + 5° to 20h 30m + 10. The train appeared like an elongated mass of red-hot cinders.

The second was at 10.30 in Ursa Minor, and appeared about midway between Polaris and γ–β Ursæ Minoris; shape unique, exactly like a starfish with five fingers, and was of a brilliant red colour.

FIREBALL OF JUNE 10th, 1897.

Described by Rev. S. J. Johnson, of Melplash Vicarage, as "a "small fireball at 9.29¾ on June 10th, Friday." (This should probably be June 11th, *see* following account.) "It was too much "in the twilight to record the track. E.S.E. sky, altitude 15° at "appearance, went downward perpendicularly to 10°, about 30° "S.W. of Vega. Pear shaped, about $\frac{1}{5}$ of the size of the moon. "Colour, white tinted with green and red."

Mr. G. B. Longstaff, then at Morthoe, North Devon, says:—"On "Friday last, June 11, at about 9.30, while it was yet quite light, "it being three days before full moon, I saw a very brilliant "meteor. The sky was so light that it was not easy to fix the "position of the meteor, and it was not seen through the whole "of its course. It was in the southern sky, about 20° E. of the "moon. It was below Saturn, and I think to the W. of Antares. "I saw it pass through about 12° and reach the horizon, either

" vertically or sloping from W. to E.; its motion was rather slow. " Brilliance at least equal to that of the moon; I think decidedly " brighter. Colour, bluish white, size larger than Venus at its " brightest; there was no train or streak, and no report was " heard."

FIREBALL OF JULY 30th, 1897.

It will be seen from Mr. Denning's table that he received at least seven reports of this fine meteor. Owing to the twilight some of the details may be inexact, but it would appear to have been directed from near β Ursæ Majoris, from a height of 54 miles, along a path 50 miles long to a height of 23 miles over the channel, at a rate of only 13 miles per second.

My own observation of it was that it fell in the S., at 8.48, and when first seen was at about the altitude of Altair, and not far to the east of it, say at 302 + 15. In about $2\frac{1}{2}$ seconds it fell down to within about 8° of the horizon. It was at first of a brilliant bluish white, and considerably brighter than Venus, and faded away, dying out as a few orange flakes.

METEOR OF SEPTEMBER 12th, 1897.

Mr. George Earngey, writes from Deniliquin, N.S.W.:—" On " Sunday last, September 12, at 8.20, a fireball was observed here. " The sky was overcast with the exception of 10° of altitude along " the E. horizon. A glare was first noticed through a small rent " some 15° above horizon, and a fireball shot from behind the " clouds. It was the shape of an Indian club, and in size about " 3 diameters of Jupiter. Its motion was rapid; its fall through " the 10° of arc could not have lasted longer than two or three " seconds. In colour it was a brilliant white opal, while the tail " part was of an Antares red, and somewhat disjointed. In its " course there were two distinct pulsations or dilations, and its " breadth at these times was somewhat greater than half the " diameter of the moon. The meteor appeared to stop at each " dilation, and the appearance was as of flame. The path was " from near δ Aquarii towards ω Piscium in a N.E. course."

METEOR OF SEPTEMBER 16th, 1897.

Another brilliant meteor in the favoured skies of Malta is thus described by Rev. T. H. Foulkes:—" I saw last night, at 11.15 " (local time), one of the finest meteors it has ever been my good " fortune to observe. It travelled very swiftly, and seemed very " near the earth. It appeared to be of the size of the moon, and " four times as bright as Venus. Its enormous head was of a " red and blue colour, with a granulated train, which was curved " and of great length, the central portion was greatly enlarged. " The meteor started near Polaris, and vanished near α Lyræ, " and in its passage lighted up the sky in spite of moonlight."

METEOR OF NOVEMBER 20th, 1897.

This meteor was observed by Mr. Fotheringham, at Sigglesthorne, near Hull, and was remarkable for its long track, of which about 90° was observed from a point in Cassiopeia to 251° + 12°

in Hercules, which it performed in four or five seconds. The motion was curiously jerky and zigzag, describing a small path with diminishing velocity, then almost stopping, turning through a small angle, and starting on again. This was repeated four or five times at least. The brightness was equal to that of Jupiter or Venus.

FIREBALL OF DECEMBER 12th, 1897.

No record of this great meteor, details of which are given in Mr. Denning's table, reached me directly, but I quote from a letter from Mr. E. R. Blakeley to the "Yorkshire Post" of December 16. "The time of appearance was $8^h\ 5\frac{1}{2}^m$, and it "traversed a fairly long path in the eastern sky, where only "Capella was visible, owing to fog and cloud, but it was evident "that the radiant point was in Taurus. I should estimate the "duration of flight at five seconds, and it moved decidedly slowly, "appearing orange red at first, and expanding with a bright "flash (like moonlight breaking out of clouds), and at the same "time changing its colour to yellowish green. Apparent size "one-fourth of the moon." Other observers in Yorkshire speak of its final explosion, at which time it threw out a shower of sparks. An observer at Ilkley heard a distinct rushing sound like a rocket. This is an assertion often made, and even that sound was heard before a meteor was noticed by the eye. It seems impossible that anything could be heard from such a distance, unless meteors make a "rushing sound" before they become visible, which does not seem likely, or that there is some other way of our appreciating sound than by the ordinary aerial vibrations. Of course it is generally assumed that such sounds being known to accompany the flight of a rocket, one is apt to ascribe them also to meteors, although non-existent as far as the observer is concerned. All such phenomena, however, should be carefully recorded. It will be seen that the meteor began at a height of 112 miles over the North Sea, and descended to only 19 miles above Thirsk, a real path of 151 miles at a speed of 30 miles per second.

PARTICULARS OF DOUBLY OBSERVED METEORS, 1897. *Contributed by* W. F. DENNING.

Date.	Time.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity (per second).	Began over	Ended over	Radiant.	Name of Meteor.	Observers.
1897.	h m		Miles.	Miles.	Miles.	Miles.			° °		
*April 22	10 25	2—2½	85	30	58	9	Cuckney, Notts.	Caunton, Notts.	161 + 59	*β Ursid*	D. B.; E. R. B.
„ 23	11 21	3—1	61	48	22	22	Hascombe	Bisley	213 − 3	*Virginid*	A. S. H.; W. F. D.
„ 23	11 37	3—1	62	53	15	21	Watlington	Denton	196 ± 0	*Virginid*	A. S. H.; W. F. D.
„ 30	9 38	5×♀	59	18	70	23	Cheltenham	Banwell, Somerset	291 + 59	*o Draconid*	W. F. D.; C. Grover and others.
May 5	12 31½	4—>1	68	48	35	20	Rochester	Braintree, Essex	221 − 3	*Libríd*	W. F. D.; H. R. Maynard.
„ 5	12 49	4—2½	75	65	33	35	Woking	Reading	296 − 1	*Aquilid.*	A. S. H.; W. F. D.
†July 30	8 47	>♀	54	23	50	13	Poole, Hants.	English Channel	155 + 59	*β Ursid*	Seven observers.
Aug. 1	10 39	4	31	16	21	24	Swindon	Chippenham	357 + 42	*Andromedid*	A. S. H.; W. F. D.
„ 1	12 14	2—1	55	42	25	Slowish	Dorking	London	296 − 6	*Aquilid*	A. S. H.; W. F. D.
¶ „ 2	10 46	3—2	44	40	7	Swift	Malmesbury	S.S.E. Malmesbury	110 + 70	*Camelid*	H. C.; W. F. D.
„ 2	10 52	4—2½	59	55	44	15	Uxbridge	Brackley	339 − 24	*Aquarid*	A. S. H.; H. C.; W. F. D.
„ 2	11 5½	2	112	90	40	Swift	Basingstoke	Southampton	40 + 55	*Perseid*	H. C.; W. F. D.
„ 2	11 24	5—4	139	124	28	Swift	Berkhampstead	Reading	73 + 66	*Camelid*	H. C.; W. F. D.
„ 3	13 40	2—1½	60	54	61	37	N.E. Margate	Mouth of Thames	72 + 11	*o Orionid*	A. S. H.; W. E. B.
„ 8	9 15	>♀	133	115	63	42	Clanfield, Hants.	English Channel	52 + 47	*Perseid*	A. S. H.; N. Lattey.

PARTICULARS OF DOUBLY OBSERVED METEORS, 1897—*continued.*

Date.	Time.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity (per second).	Began over	Ended over	Radiant.	Name of Meteor.	Observers.
1897.	h m		Miles.	Miles.	Miles.	Miles.					
Aug. 9	13 27	3—1	140	77	81	100	Thrapston, Northampton.	Banbury, Oxon -	46 + 56	*Perseid*	A. S. H.; W. E. B.
„ 9	13 52	3—3	131	89	56	Swift	Wareham, Dorset -	12 miles S. W. of Portland Bill.	58 + 60	*Perseid*	A. S. H.; W. E. B.
„ 9	14 18	3× ♀	137	75	75	Swift	English Channel -	English Channel -	44 + 45	*Perseid*	A. S. H.; W. E. B.
„ 11	11 15	1—>1	79	57	37	Swift	Reading - -	Stockbridge, Hants.	47 + 55	*Perseid*	W. F. D.; J. A. H.
¶Sept. 26	11 50	4	41	35	6½	Slow	Wallingford -	New Wallingford -	36 + 43	*θ Perseid*	A. S. H.; J. A. H.
‡Oct. 22	6 23	>♀	59	35	171	Slow	Wooler, Northumberland.	North Sea - -	218 + 10	*Boötid*	T. R. Clapham and others.
Nov. 13	15 28	1	125	77	75	Swift	44 miles E. of Harwich.	Halesworth -	136 + 9	*Cancrid*	J. C. W. H.; W. E. B.
„ 13	15 52	1	103	59	60	Swift	Strait of Dover -	Cranbrook, Kent -	152 + 22	*Leonid*	W. J. H.; W. E. B.
Dec. 9	9 47	>♀	76	21	90	Slow	Aldeburgh E. Coast	Roydon, Herts. -	113 + 32	*Geminid*	E. H. Cullum and others.
„ 12	8 6	>♀	112	19	151	30	North Sea - -	Thirsk, Yorks. -	80 + 23	*ζ Taurid*	E. H. Cullum and others.

* The radiant is very doubtful, and may be further west, in the direction of Perseus.
† The heights and adopted radiant are somewhat uncertain.
‡ The observations are somewhat conflicting, and the path derived from them only approximately correct.
¶ These meteors are remarkable for their extremely short, visible paths.
N.B.—The unusual height of several of the meteors will be noticed

SECTION FOR THE OBSERVATION

OF

THE SUN.

DIRECTOR.—MISS E. BROWN, F.R.MET.SOC.

SEVENTH REPORT OF THE SECTION, 1897.

Introduction.

This report, the seventh issued since the commencement of our Association, will be found to correspond in arrangement with those of the two previous ones, both as to the Calendar and Ledger. With regard to the latter, it may be well to mention that faculæ are recorded only when conspicuous, special attention being given to those appearing without any spots, and also when preceding or following them. It is needless to say that they are always present in spot groups, a fact which has been proved by the wonderful photographs taken by Prof. Hale, at Chicago.

An interesting article, by the Rev. Arthur East, elucidating this subject, appeared in the August number of "Knowledge" (1898).

The total number of groups recorded in 1897 amounts to 130 as against 161 in 1896.* On 21 days no spots were visible. During the previous year on only 3. The blank days on which no record was obtainable are, however, in excess, being 31 instead of only 19 as in 1896.

In referring to the accompanying illustrations, the Director regrets being unable to reproduce any of the photographs contributed, many being either on too small a scale or not sufficiently clear.

The examples chosen require a brief explanation.

Plate I. is from a drawing by M. Antoniadi of the large January group, of which two, by Prof. Pereira, have already appeared in

* NOTE.—Or, including sundry very small groups, formerly omitted in the reckoning, but appearing in the Ledger, 148 in 1897, as against 179 in 1896.

the "Journal" (Vol. VII., p. 204), and one on January 31, from a sketch by Mr. Corder, taken when the same spot returned after rotation (Group 19).

Plate II. shows Group 20, a typical normal spot, on February 17, when one day W. of the central meridian; also Group 23 in which a singular detachment of a portion of the penumbra took place, and Group 30 in which a train of small spots, instead of following the leader equatorially, as is generally the case, were found streaming first to the S., and finally preceding it in a westerly direction.

Plate III. exhibits the striking changes which took place in Group 55 in the course of a few hours, the nucleus being curiously subdivided, a peculiar feature which occurred again in Group 89 (September 9).

Plate IV. is devoted to Group 77, one of the largest outbursts during the year. The "black holes" are conspicuous in the drawings by Prof. Pereira on August 5 and 8.

Plate V. is a reproduction of drawings published in the "Journal" (Vol. VIII., No. 4), of the remarkable group in December last.

NAMES of MEMBERS who have sent regular contributions during the year.

Name.	Address.	Instrument.	
BARTLETT, J.	Bramley	4-in. O.G.	Drawings (projection).
BROWN, Miss E.	Cirencester	3½-in. O.G.	Drawings, measurements of position.
CORDER, H.	Bridgwater	6½-in. Spec.	Drawings (projection).
ELD, The Rev. F. J.	Polstead Rectory.	8½-in. Spec.	Measurements of position.
HADDEN, DAVID E.	Alta, Iowa, U.S.A.	4-in. O.G.	Daily record.
PEREIRA, J. DE MORAES.	Azores	4½-in. O.G.	Drawings and measurements of position.
SMART, Dr. D.	London	10-in. Spec.	Photographs and measurements of position.
TOWNSEND, J. S.	Sevenoaks	4½-in. O.G.	Photographs and diagrams.
WAUGH, The Rev. W. R.	Portland	4½-in. O.G.	Drawings (direct vision).

E. BROWN,
Director of the Section.

Calendar of Sun-spots and Faculæ.

JANUARY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	1, 2, 3, 4	E. 20° S. W. region of group 1.
2	2, 3, 4, 5	E. 4° to 10° S. and 17° to 22° S. W. 20° to 25° N., and near equator.
3	3, 4, 5, 6.	
4	3, 4, 5, 6.	
5	3, 4, 5, 6, 7.	
6	3, 4, 5, 6.	
7	3, 4, 5, 6.	
8	5, 6.	
9	5, 6.	
10	5, 6.	
11	5, 6.	
12	5, 6.	
13	5, 6, 8, 9	E. region of 8 and S. p. W. region of 6, and S. p. it.
14	5, 6, 8, 9.	
15	6, 8, 9, 10, 11	E. 9° to 30° S. W. 0° to 15° S.
16	8, 9, 10, 11.	
17	8, 9, 10, 11, 11A	E. numerous, 6° to 17° S.; 60° to 70° E. W. 5° to 12° S.
18	8, 9, 10	E. 10° N., faint; 6° to 14° from limb to nearly 50° E. of centre. W. 7° to 13° S.
19	8, 9, 10, 12.	
20	8, 9, 12	W. about 20° S.
21		
22	8, 9, 12	E. 13° N. 15° to 20° S. 13° N.
23	8, 9, 12, 13	E. faint, far from limb. 15° to 20° S.
24	8, 9, 12, 13, 14	E. 14° to 26° S. W. 14° to 29° S.
25	12, 15	E. 0° to 10° N. W. 2° to 20° N. 5° to 25° S.
26	12, 15, 15A	E. 0° to 12° N. 0° to 3° S. W. 0° to 13° N. 0° to 16° S.
27	15	E. 10° to 22° S.
28	15.	
29	15, 16, 17	E. 0° to 3° N. 0° to 23° S.
30		
31	15, 17, 18, 19.	

FEBRUARY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2	15, 17, 18, 19	W. 5°, and 15° N.
3	15, 17, 18, 19.	
4	15, 17, 18, 19	E. 5° to 15° S. W. 3° to 15° N.
5		
6	17, 17A, 18, 19.	
7	17, 17A, 18, 19.	
8		
9	19, 20.	
10	19, 20	E. 0° to 15° N. 15° to 30° S. W. 5° to 25° S.
11	19, 20, 21	E. 3° to 10° N. 15° to 30° S., fainter. W. 0° to 15° S.
12		
13		
14	20, 22.	
15	20	W. 20° S.
16		
17	20	W., about 15° S.?
18	20	W., p. group 20.
19		
20	20.	
21	20	E., near equator. W. 2° to 20° N. 15° to 32° S.
22	23	E. 5° to 33° N. W. 2° to 15° N.
23	23, 24	E. 0° to 24° N. 0° to 6° S. Position of group 25.
24		
25		
26	23, 24, 25, 26	E. 3° to 15° S.
27	23, 24, 25, 26 27	E. 0° to 7° N. 0° to 18° S.
28	23, 24, 25, 26, 27.	

MARCH 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	23, 24, 25, 26, 27.	
2	23, 24, 25, 26, 27	E. 8° S. Few.
3	23, 24, 25, 26, 27	
4	23, 24, 25, 26, 27	W., round and N. of group 23.
5	23, 24, 25, 26, 27	W. 5° to 25° N.
6	23, 24, 25, 26, 27	W. region of 24 and 25.
7	25, 26, 27, 28	W. 0° to 12° N. and 0° to 13° S.
8	26, 27, 28, 29, 30	E. region of 29 and 30° W. 8° to 13° N.
9	26, 27, 29, 30, 31, 32	W. 0° to 10° N. 0° to 14° S.
10	26, 27, 29, 30, 31, 32, 33	E. 3° to 18° N. 10° to 30° S. W. 0° to 8° N. 0° to 14° S.
11	29, 30, 31.	
12	30, 31, 34	W. region of 31, about 3° to 8° N.
13	30, 31, 34	W. 0° to 7° N.
14	30, 34.	
15	30, 34	W. region of 34.
16	30, 34	W., same position.
17	30, 34	W. bright patch, same position.
18	30	W. p. group 30.
19	30	E. to the N., far from limb. W. extensive p. and N. f. 30.
20	30	W. region of group 30.
21	No spots	E. 3° to 7° and 10° to 15° N. 4° to 7° S. W. 7° to 15° N.
22	35	E. 12° to 16° N. S.E. region of 35.
23	35	N.E., same position as yesterday, S.E. N. of 35 and f. it.
24	35, 36	E. region of 36.
25	35, 36	E., a few, about 15° S.
26	35, 37	E. region of 37.
27	35, 37	E. 3° to 25° S.
28	35, 37, 38.	
29	35, 37, 38	E. 0° to 11° N. 0° to 3° S.
30	35, 37, 38	E. region of group 38.
31	35, 37, 38.	

APRIL 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2		
3		
4	37A, 38, 39, 40, 41.	
5	37A, 38, 40, 41	E. 0° to 10° N. 0° to 3° S.
6		
7	38, 39, 40, 41, 42, 43, 44.	
8	38, 40, 41, 42, 43, 44, 45, 46	W. 0° to 10° N.
9	40, 41, 43, 44, 45, 46	W. 0° to 15° S.
10	40, 41, 43 44, 45, 46, 47, 48, 49	W. region of group 43.
11	40, 41, 44, 45, 46, 47, 48, 49	W. 0° to 12° N. 0° to 5° S.
12		
13	40, 44, 45, 47, 48.	
14	44, 47, 48	N.E., W. region of 41.
15	44	W. around 44 and a stream N. f. it.
16	50.	
17		
18	50, 51	E. 5° N. and 15° to 20° N.
19		
20	51, 52.	
21	51, 52.	
22	No spots	A few near W. limb position of group 20 ?
23	No spots	E. a patch near W. limb.
24	52A, 52B, 53	E. far from limb.
25	53	Region of 53.
26	53.	
27	No spots	A few N.E. and a very few W.
28	No spots.	
29	54, 55	E. region of 55, and 6° S. 65° E.
30	54, 55, 56	

MAY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	54, 55, 56	E. p. group 56, and f. 57.
2	55, 56, 57	E. f. 56 and 57.
3	55, 56, 57.	
4	55, 56, 57.	
5	55, 56, 75, 57A	E. with a very small spot at 5 p.m.
6	55, 56	S.E. near limb.
7	55, 56.	
8	55, 56.	
9	55, 56	W. f. group 55.
10	55, 56	W. well marked stream S. of 55.
11	55, 56	W. region of 55.
12	56.	
13	No spots.	
14	57B.	
15	No spots.	
16	No spots.	
17	No spots.	
18	No spots.	
19	58	E., two patches near limb (region of 58?).
20	58, 59.	
21	58, 59.	
22	58, 59	E. near limb, on a line with 59.
23	58, 59.	
24	58, 59.	
25		
26	58, 60	Region of 60.
27	60, 61	E. around and S. f, 60.
28	60, 61	W. conspicuous near limb, position of 59.
29	60, 61	E. f. group 61.
30	60, 61	Around 60 a complete ring, only 10° from central meridian.
31	60, 61.	

JUNE 1897.

Day.	Groups of Sun-spots.	Faculæ.
1		
2	60, 61.	
3	60, 61	E., N. of equator.
4	60, 61.	
5	60, 61	W. 5° to 15° S.
6	60	A very bright patch to the N.W. S. f. group 60, and one N. of it.
7	61A	E. patches far from limb, a minute spot in them (Hadden).
8	No spots	E. limb.
10	No spots	E. limb.
11	No spots.	
12	62	E. 18° to 35° N.; 8° to 22° S., without spots.
13	62, 62A.	
14	62	
15	62, 62A	E. 0° to 13° S. W. region of 62.
16	62.	
17	No spots	E. limb (position of 63?) one patch.
18	No spots.	
19	No spots.	
20	62B, 63	E. around 62B, and p. 63.
21	62B, 63.	
22	62B, 63, 64	E. region of 63.
23	63, 64	E. S. f. 63.
24	63, 64.	
25	63.	
26	63.	
27	63	W., a bright patch, S.
28	63, 65.	
29	63, 65	E. conspicuous around 65.
30	63, 65	E. region of 65. W. far from limb to the S.

JULY 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	63, 65	E. conspicuous on a line with 65. W. around 63.
2	63, 65	E. same position as on the 1st.
3	63, 65, 66	E. region of 66, and S. p. far from limb. W. around 63 and 65.
4	65, 66	E. around and f. 66. W. limb, region of 63?
5	65, 66	E. limb f. 66. S.W.
6	65, 66, 67	E. region of 67.
7	65, 63, 67, 68	E. slight around 67.
8	65, 66, 67, 68	E. 3° to 18° S. W. around 65.
9	65, 66, 67, 68	W. numerous, region of 65.
10	66, 67, 68	E. 12° to 26° N. W. 7° to 16° S. Conspicuous around and S. f. 68.
11	66, 67	W. position of 68, conspicuous; some far from limb.
12	66, 67	W. around 66, and some round patches near limb.
13	66, 67, 69, 70, 71	Around 67; although near the central meridian.
14	66, 67, 69, 71	W. around 69, and S. f. 66 W.
15	67, 69, 70, 71	W. around 70, and f. 69.
16	67, 69, 70, 71	W. 0° to 10° N. 10° to 20° S., and around 67.
17	71	E. small. W. extensive, 0° to 10° N., 0° to 20° S., both near and far from limb.
18	71	W. very conspicuous 5° to 15° S.
19	71, 72	E. around 72 and W. 5° to 10° S.
20	72, 73.	
21	72, 73, 74	E. numerous around f. 74, region of 73. W. some distance from limb (a couple of minute dots S.W. of centre).
22	72, 73, 74	E. around 73 and 74. W. numerous, 3° to 7° S. Position of 71.
23	73, 74	W. limb.
24	73, 74	E. a little N.; a patch S.W.
25	73, 74	E.
26	73, 74.	
27	73, 74.	
	73, 74	E. and W. limbs, rather faint.
29	73, 74, 75.	
30	73, 74, 75	E. bright circular patches, 20° to 25° S. W. region of 73 and 74.
31	73, 74, 75, 76	E. around and S. of 76: also marked f. it at 6 p.m. W. f. 73 conspicuous, 7° to 20° S.

AUGUST 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	74, 75, 76	E. 10° to 15° S., f. group 76.
2	76	E. around 76. 10° to 15° S. far from limb. A patch to the N.
3	76, 77	E. extensive, region of 77.
4	77	E. the same region. W. 7° to 14° N. Some distance from limb.
5	77, 78	E. 10° to 20° S.
6	77, 78	E. f. 78.
7	77, 78	N.E. a few patches near limb.
8	77, 78, 78A	N.E. several distinct patches. W. limb, around 78A.
9	77, 78, 78A, 79	E. 10° N. 10° S.
10	77, 78, 80	E. 17° to 26° N.
11	77, 78, 80	E. region of 80°, p. 77 faint.
12	77, 78, 78B, 81	W. a patch p. 77, half way between it and limb.
13	77, 78, 78B, 81	W. numerous surrounding 77.
14	77, 78, 78B, 81	E. 16° to 27° N. at 20° N., stretching out horizontally. W. 2° to 20° S.
15	78, 78B, 82	
16	78, 78B, 82	E. 6° to 15° S. Some patches far from limb. W. 10° to 20° S.
17	82	E. around 82 and S. of it. A few patches at some distance p. W. close to limb, position of 78.
18	82	W. 5° to 10° S.
19	82.	
20	82.	
21	82	N.W. a few round patches.
22	82, 83	E. a small bright patch.
23	82, 83.	
24	82, 84	W. p. 82, slight.
25	82, 84.	
26	82, 84A, 85	W. region of 82.
27	82, 85	E. a few patches in a line with each other, far from limb. W. region of 82, and patches to the S.
28	85.	
29	86	E. numerous p. 86.
30	86	E. 0° to 16° S.W., branching, 15° to 25° S.
31	86, 87, 88	E. 0° to 2° N. and 12° N. 0° to 15° S.

SEPTEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	86, 87, 88.	
2	86, 87, 88, 89	E. p. group 89 and f. 88.
3	86 87, 88, 89	E. 10° to 20° S.
4	86, 87, 88, 89	E. 15° to 19° S.; N. f. 89.
5	86. 87, 88, 89.	
6	86, 87, 88, 89, 90.	
7	86, 87, 83, 89, 90	S.E. near limb.
8	86, 87, 88, 89, 90, 90A.	
9	86, 87, 88, 89, 90	W. around groups 86 and 87.
10	86, 87, 88, 89, 90	W. 5° to 20° S.
11	86, 88, 89, 90	W. 5° to 20° S. and N. around 88.
12	88, 89, 90, 91	W. 0° to 17 N.; 10° to 30° S.
13	89, 91	E. 3° to 13° S. W. 10° to 15° N.; 8° to 20° S.
14	89, 92, 93	W. region of 89.
15	92, 94	E. 0° to 12° N.
16	94	E. 0° to 12° N.; 0° to 10° S.
17	94, 95	E. s.f. 94 and N.W.
18	94, 95	W. 0° to 12° S.
19	94, 94, 96.	
20	94, 95, 96, 96A, 97.	
21	94, 95, 97, 98, 99	E. 0° to 16° N.; 0° to 3° S.
22	97, 98, 99.	
23	97, 98, 99, 100, 101	E. f. group 99. S.W. position of 95?
24	97, 08, 99, 100, 101,	
25	97, 98, 99	E. 3° to 13° S.; W. 0° to 10 N.; 0° to 3° S.
26	97, 98, 99, 99A, 102	E. 4° to 15° S.
27	97, 98, 99, 102, 103	E. 8° to 20° S. and region of 103.
28	98, 99, 102, 102A.	
29	99, 102, 102A, 103, 104	
30	99, 102, 103, 104	E. region of 104, and 8° to 20° S. extending far from limb.

OCTOBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	99, 102, 103, 104	E. about 10° to 20 S. W. region of 99.
2	102, 103, 104	E. 7° to 20° S. W. 0° to 15° N.
3	102, 103, 104.	
4	102, 103, 104, 104A	E on equator. W. N. of equator.
5	102, 103, 104, 104A, 105	E. around and f. 105. W. numerous half way between 102 and limb.
6	102, 103, 104, 105	E. same as on the 5th. W. near limb p. 102, and patches S. of it.
7	102, 103, 106	W. region of 102, One patch more S.
8	102, 103	W. scattered patches 20° or more S., far from limb.
9	No spots	E. small patch, about 22° S. W. 0° to 20° S. conspicuous.
10	107.	
11	107	E. 2° to 14° N. S.W. far from limb.
12	107	E. f. group 107. W., scattered, far from limb.
13	107, 108.	
14	108.	
15	No spots.	
16	109.	
17	109	W. at three different distances from limb, N.
18	109	E. patches 8° and 5° N. W. 14° N.
19	109	A few E. and W. not very near limb.
20	110, 111	E. around group 111.
21	110, 111.	
22	111.	
23	111?	E. near limb; also W.
24	111	Two small spots observed only by Mr, Hadden near centre of disk, and two more a little S. of 111.
25	111	E. patches, one very far from limb.
26	No spots	E. extensive.
27		
28	No spots	E. small bright "knot."
29	No spots	E. 12° to 14° S. W. 5° N.
30	No spots.	
31	No spots.	

NOVEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	112.	
2	113, 114	E. around 114. W. position of 112.
3	114	E. region of 114 numerous.
4	114.	
5	114	(Dots near the small spot 114 observed by Mr. Hadden.)
6	114.	
7	114	None seen, although clear.
8		
9	No spots	W. limb, small.
10	No spots.	
11	No spots	E. prominent to the S.
12	115.	
13		
14	115.	
15	115	E. a patch near limb. W. 5° N. far from limb; 14° S.
16	No spots	E. small patch.
17	115	(Three small spots near centre. Hadden.)
18	116?	
19	116.	
20	116, 117	W. around 116 and f. it.
21		
22	118	E. near equator 13° and 17° S. W. 15° N.; 3° to 7° N. 13 S.
23	No spots	E. far from limb. W. a small patch.
24	No spots	E. close to limb.
25		
26	118A, 119?	(Faculæ and a small spot 119 close to E. limb—Hadden.)
27		
28		
29	119, 120, 120A	E. 10° to 12° S. around 120A. W. near limb, circular patch N.
30		

DECEMBER 1897.

Day.	Groups of Sun-spots.	Faculæ.
1	119, 120A	E. 0° to 4° S.; 15°? S.
2	119, 120A, 121?	E. one large patch, bright, 17° S. With trace of a spot group 121?
3	119, 120. 121.	
4		
5	119, 121, 133	E. region of 123.
6	119, 121, 122, 123, 123A, 124	E. region of 123, 124. W. around 119.
7	119, 121, 123, 124.	
8	119, 121, 123, 124, 125	E. region of 124.
9	121, 123, 124	E. f. 124. W. position of 119?
10		
11	121, 124, 124A.	
12	121, 124, 124A.	
13	124.	
14	124, 126.	
15	124, 126, 127	E. 10° N.? W. about 8° N.
16	124, 127.	
17	124, 127	W. region of 124, and more N.
18	124, 127	W. region of 124.
19	124, 127.	
20	127	W. region of 124.
21	127.	
22	127.	
23	127.	
24	127	E. extensive, 3° to 16° N.
25	No spots	E. same position? further from limb.
26	128.	
27		
28	128	E. region of 130; 8° N.
29	128, 129, 130	E. region of 130.
30		
31	121, 129, 130.	

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LEDGER.

Jan. GROUP 1. *Long.* 164°. *Lat.* 14° S.

1. A small spot close to W. limb at 11 a.m. (One of the f. spots of Group 160, December 1896.)

Jan. GROUP 2. *Long.* 96°. *Lat.* 19° S.

1-2. A few very small spots W. of the central meridian. On the 2nd one only.

Jan. GROUP 3. *Long.* 49°. *Lat.* 12° S.

1-7. A normal spot, major axis about 30″. At first with a few small followers; when not far from the central meridian, circular; when near W. limb no observations obtained. (Group 161 of December 1896.)

Jan. GROUP 4. *Long.* 22°. *Lat.* 6° S.

1-7. A small normal spot (observed December 29, 1896). Nucleus curving westward on the 3rd, major axis 25″. Two small spots on the 7th.

Jan. GROUP 5. *Long.* 350°. *Lat.* 8° S.

2-14. A penumbral spot with somewhat irregular nucleus; ear-shaped on the 6th. A few small outliers f. on the 7th, major axis 45″. It became normal on the 9th, and again ear-shaped on the 10th, split into two equal parts on the 13th, but single when last observed on the 14th.

Jan. GROUP 6. *Long.* 342° to 329°. *Lat.* 2° to 9° S.

3. A considerable spot near E. limb, with an unusual amount of penumbra confined to the f. side. When first seen nucleus not exceeding in area that of the p. spot. (Group 5.)
4. Increasing, but giving no idea of the area it afterwards attained; penumbra still confined to the f. side; many small nuclei.
5. A large oval nucleus p. "followed by a branching stream of penumbral matter with nuclei." Weather in England almost entirely overcast after the 3rd. Observed chiefly in the Azores.
6. Area now enormous. Mr. Maunder computes the length to be 15°, or 115,000 miles, the breadth 6°, or 47,000 miles. (*See* "Journal" Vol. VII., p. 205.) One principal nucleus, five-lobed, and surrounded with penumbra. A mass of smaller spots streaming eastward with sharp nuclei and fragmentary patches of penumbra.
7. Nucleus broadly three-lobed, prolonged at the eastern extremity; penumbra branching out above and below. The f. spots more confluent and connected, but curving to the N. (A reddish brown tint perceptible.)
8. Main spot more inclined to the equator, nucleus very large.
9. Nucleus becoming elongated, with a bridge perceptible and a remarkable promontory showing a curve of at least 90° "indicating a whirlpool with motions in the direction of watch hands." The f. spots diminishing. (Observations and illustration by M. Antoniadi.)
10. Nucleus rounded in front and fimbriated; a thin bridge across the denser part at 1.30, which had almost disappeared at 2. Outline very complicated, somewhat resembling a scorpion. Black holes visible at 1.45. The whole changing under the eye.

Jan. GROUP 6—*continued.*

11. Nucleus of a dark uniform tint, except a portion on the northern edge near the centre which is much lighter. The surrounding penumbra breaking up, and outlines less defined. The penumbra of the f. spots lighter in tint and studded with dots.
12. Already much foreshortened, nucleus still expanded in front, but with a sharp ring-like excrescence to the N. penumbra more indented; outlying spots fewer at the rear, many penumbral patches to the S. interlacing each other.
13. The penumbral patches still more dissected.
14. Nucleus still large and dense, the sharp excrescence dissevered from it, also a portion to the E. appearing at right angles to the p. leaving a space void of penumbra.
15. Two distinct nuclei. At noon penumbra very narrow towards the limb.

Jan. GROUP 7. *Long.* . *Lat.* about 10° or 12° S.

5 A tiny pair not far from W. limb. (Prof. Pereira.)

Jan. GROUP 8. *Long.* 212°. *Lat.* 19° S.

13. An irregular spot near E. limb, with a smaller one to the S.
14. Penumbra branching to the N.; spot to the S. almost gone.
15. Several nuclei, spot to the S. larger.
16. The S. spot again reduced.
17. Very compound, penumbra drawn out to the N.
18. In outline resembling a quatre-foil, nuclei small, hardly more than dots to the S.
19. Three nuclei.
20. Three distinct nuclei, penumbra chiefly on the N. f. side.
22. Much reduced, no near outliers, two more distant f.
23. Very small and faint.
24. Near limb.

Jan. GROUP 9. *Long.* 206°. *Lat.* 8° S.

13. A nuclear spot very near E. limb at 12.45.
14. Curved, nucleus double.
15. Divided.
16. Dwindling.
17. Nebulous, a pair.
18. Again almost in contact at 11. Mr. Bartlett observed three nuclei at noon.
20. Little change.
22. Penumbra on the N. p. side.
23. Reduced to a small pair without penumbra.
24. One faint little spot.

Jan. GROUP 10. *Long.* 266°. *Lat.* 12° S.

15. A small faint spot near the central meridian.
16. A pair.
17. A wide pair.
18. A double pair.
19. A few minute spots.

Jan. GROUP 11. *Long.* 198°. *Lat.* 18° S.

15–17. A very small spot which showed but little increase.

Jan. GROUP 11A. *Long.* 173°. *Lat.* 15° S.

17. A small spot not very far from W. limb.

Jan. GROUP 12. *Long.* 201° to 193. *Lat.* 6° to 8° N.

19. A few small spots a little E. of the central meridian.
20. Very irregular.
22. A stream less than usually inclined to the equator. Leader larger than the rest.

Jan.
23. Leader 1′ of arc in major axis, the f. increased; another large spot apparently in course of formation.
24. The two large spots nearly equal in area, nuclei smaller. The intermediates almost gone.
25. Leader with penumbra on the f. side and one nucleus.
26. The f. spot near W. limb.

Jan. GROUP 13. *Long.* 186°. *Lat.* 7° N.
23–24. A few little spots in two sets, widely separated. On the 24th one spot only, the f. set gone.

Jan. GROUP 14. *Long.* 171° to 169°. *Lat.* 10° to 12° N.
24. Little spots in two sets, but hardly larger than dots.

GROUP 15. *Long.* 59°. *Lat.* 6° N.
Jan. 25–Feb. 4. A normal spot showing but little variation; major axis about 50″. Nucleus with four divisions on January 31, bridged in two places on February 2, afterwards entire; a few outliers on January 29. Details difficult to obtain on account of cloudy weather.

Jan. GROUP 15A. *Long.* 119°. *Lat.* 2° S.
26 A tiny spot near the central meridian (Prof. Pereira).

Jan. GROUP 16. *Long.* 86° to 83°. *Lat.* 18° N.
29. Two small spots near the central meridian.

Jan. GROUP 17. *Long.* 25°. *Lat.* 2° S.
29. A faint little spot at some distance from E. limb.
Feb.
1. A little stream.
2. The leading spot larger, normal. The f. spots about 8° more E.
3. The f. spots more inclined to the equator.
4. Major axis nearly 1′ of arc. Nucleus three-lobed. A penumbral spot closely f. The f. spots more numerous.
6. Nearly normal.
7. Nucleus indented to the N. The penumbral spot dispersed.

Feb. GROUP 17A. *Long.* 17°. *Lat.* 10° to 11° S.
6–7. A few little spots widely separated; one only with penumbra.

Jan. GROUP 18. *Long.* 40° to 35°. *Lat.* 13° N.
31. Four little spots, the p. with slight penumbra.
Feb.
2. A cluster; spots all small.
3. Much increase in area, especially in the first and last.
4. Two spots, major axis of each about 50″, nuclei very irregular.
6. The p. near W. limb, nucleus double, the f. reduced.
7. The p. very near limb at 10.30. The f. very small.

Jan. GROUP 19. *Long.* 347°. *Lat.* 4° to 6° S.
31. A large normal spot, nucleus bridged. A return of the large January group. Two smaller f. (*See* illustration.)
Feb.
2. Nucleus of main spot entire; two spots closely following nearly normal.
3. Nucleus pointed on the S. f. side and curiously bridged.
4. More serrated and elongated eastward, black holes observed but no bridge in nucleus.
6. Nearly circular, 30,000 miles in diameter, a trail of dots N., the two f. spots little changed.
7. Nucleus hooked to the eastward, more scattered outliers.
9. Nucleus cloven to the N. and S. (Mr. Wykes.)
10. Cloven only to the S., penumbra opening on the N. f. side with a small nucleus apparently detached.
11. Near limb, penumbra nearly equal on both sides; small nucleus still visible. Three spots to the S.

Feb. GROUP 20. *Long.* 212°. *Lat.* 7 N.

9. A large spot very near E. limb at 10.
10 Both nucleus and penumbra cloven at the base.
11. Nucleus fimbriated at the base.
14. Major axis 45″, nucleus still cloven, a few small followers.
15. On the meridian, slightly elongated.
17. No longer cloven. (*See* illustration.)
18. Many little outliers.
20. Little change.
21. Near limb, reduced. (In position not very far from Group 12.)

Feb. GROUP 21. *Long.* 266°. *Lat.* 3° S.

11. A pair of dots N. and S. of each other on the central meridian.

Feb. GROUP 22. *Long.* 244°. *Lat.* 16° N.

14. A very small pair to the W. of the central meridian.

GROUP 23. *Long.* 46°. *Lat.* 12° N.

Feb. 22–Mar. 6. A penumbral spot with a double nucleus attaining 1′ of arc in major axis. It showed signs of division on the 26th, and a portion of the penumbra became detached (*see* illustration), on this and the following day. On March 1 this detachment closed up again, two or more small nuclei occupying the lately vacant space. The spot was much reduced when near the W. limb.

Feb. 23–Mar. 6. GROUP 24. *Long.* 35°. *Lat.* 1° S. Another normal spot, near E. limb on the 23rd, which showed little change. Major axis 45″ on March 1. Area nearly the same when near E. and W. limbs.

Feb. GROUP 25. *Long.* 29° to 20°. *Lat.* 2° to 6° S.

26. A scattered stream of small spots and dots.
27. Very faint, only a few visible.
28. No details.

Mar.

1. Rather more in number.
2. Many more, also to the N. and S., but little increase in area.
3. Great increase, the leading spots coalescing and forming one nearly equal to Group 24. Those at the rear also increasing; no intermediates.
4. Leader 45″ in major axis opening eastward, with small nuclei streaming from it. The rear spots decreasing, with dots towards the West.
5. Leader with divided nucleus; the rear spots in a little dense cluster.
6. Broken up on the f. side, the cluster become a single spot with two nuclei.
7. Close to W. limb at 6.12 p.m.

Feb. GROUP 26. *Long.* 347°. *Lat.* 7° S.

27–Mar. 10. A normal spot (the second return of the large January group). Nucleus curved when near limb, penumbra nearly equal on both sides. It showed little change, except some variation in the form of the nucleus, which was crenated on the 4th, bridged on the 6th, and slightly curved when near W. limb. It gradually decreased in area, the major axis being 55″ on the 2nd and 45″ on the 6th.

Feb. GROUP 27. *Long.* 352°. *Lat.* 3° N.

27–Mar. 10. Another normal spot, about half the area of 26; penumbra on the f. side when near E. limb. Nucleus divided on March 1, entire on the 3rd, subdivided on the 5th and 6th, with small nuclei, as it were, ejected eastward, still remaining on the 8th. A few small followers on the 4th, forming a stream. When near W. limb much reduced.

Mar. GROUP 28. *Long.* 295°. *Lat.* 3° S.

7–8. A few tiny spots near the central meridian.

Mar. GROUP 29. *Long.* 307°. *Lat.* 5° N.

8–12. A small spot near E. limb, with slight penumbra, which rapidly declined; was last observed at 8.15 on the 12th, but an hour or two later had disappeared.

Mar. GROUP 30. *Long.* 216°. *Lat.* 3° to 5° N.

8. A penumbral spot very near E. limb at 10.30, in nearly the position of Group 20.
9. Little change.
10. Nucleus angular.
11. A portion of the nucleus detached.
12. Penumbra bulging round the detached portion.
13. Larger nucleus cloven at the base.
14. Pointed at the base.
15. A sudden outbreak of small spots to the S. in two compact streams.
16. Streams more dispersed, curving westward. (*See* Illustrations.)
17. Main spot, with two smaller ones closely following, one stream curving round at the W. extremity.
18. The 2 spots more distant from the main one. Stream still more westward, and components separated.
19. Nearing limb, reduced. Stream fast disappearing.
20. Two spots only visible.

Mar. GROUP 31. *Long.* 306°. *Lat.* 5° N.

9–13. Two very small spots in the western hemisphere, the p. with double nucleus on the 10th, but afterwards dwindling.

Mar. GROUP 32. *Long.* 258°. *Lat.* 4° N.

9–10. Three little spots in a line, on the 10th one only.

Mar. GROUP 33. *Long.* 281°. *Lat.* 13° S.

10. A wide pair of very small spots.

Mar. GROUP 34. *Long.* 265° to 262°. *Lat.* 7° N.?

5–17. One or two very small faint spots; more in number on the 15th and 16th; at last one only. Not in the Greenwich record (4547), but probably seen on the 17th by E. B. more S.

Mar. GROUP 35. *Long.* 41°. *Lat.* 2° S.

22–31. A penumbral spot not far from E. limb on the 22nd, showing little change, but somewhat decreasing. A few small outliers appeared on and after the 26th. The major axis could hardly have exceeded 20″ on the 30th.

Mar. GROUP 36. *Long.* 43°. *Lat.* 11° to 13° N.

24–25. One or two little spots, afterwards a stream; no increase in area.

Mar. GROUP 37. *Long.* 341°. *Lat.* 13° S.

26–April 2. A small spot with slight penumbra very near E. limb on the 26th. In major axis it did not exceed 30″ or 35″. It showed little radical change; two outliers only were observed on the 29th. The penumbra had a singular oval-shaped opening to the S. on the 31st. (In the same longitude as the larger group of January, but more S.)

April GROUP 37A. *Long.* 326° to 322°. *Lat.* 13° to 15° S.

4–5. Three small spots, the p. with slight penumbra; a cluster on the 5th.

Mar. GROUP 38. *Long.* 319°. *Lat.* 3° N.

28–April 2. A small normal spot, nucleus divided on the 31st. Some outliers chiefly to the S. on the 7th. Major axis 35″. When nearing the W. limb somewhat reduced. (N.B.—Three very similar spots were visible at the same time.)

April. GROUP 39. *Long.* 334°. *Lat.* 2° N.
4. A small spot with slight penumbra in the western hemisphere, probably one of those observed by Mr. Hadden on the 7th.

April. GROUP 40. *Long.* 261°. *Lat.* 3° S.
4–13. A normal spot, major axis about 30″. But little change took place; nucleus double on the 4th, irregular on the 8th, decreasing on the 13th.

April. GROUP 41. *Long.* 232°. *Lat.* 5° N.
4–11. A small penumbral spot not far from E. limb. on the 4th. Major axis hardly more than 25″. Nucleus forked on the 8th; one or two outliers. By the 10th broken up into small fragments.

Ap. GROUP 42. *Long.* 291°. *Lat.* 8° S.
7–8. Some small spots in two sets following each other. Few details were obtained, and no note of their first appearance.

Mar. GROUP 43. *Long.* 289°. *Lat.* 11° S.
31–April 10. A few little spots. In two sets on the 8th, more in number than those in Group 42. When near limb on the 10th faint, but more numerous.

April. GROUP 44. *Long.* 221°. *Lat.* 2° N.
7–15. A considerable spot, three days E. of the meridian. On the 7th inclined to the equator. Major axis 45″ on the 8th, with an extension of the penumbra eastward; a few dots N., f. Almost circular on the 10th, with a gap in the penumbra and a trail of dots, on the 11th normal, nucleus with a cleft to the N. on the 13th, curved on the 14th. Penumbra equal on both sides when near limb. Longitude 227° when near W. limb. Seen as one or two very small spots on April 4 and 5.—(Greenwich Record.)

Apr. GROUP 45. *Long.* 220°. *Lat.* 7° N.
8–13. A penumbral spot, probably appearing at an earlier date to the N. of Group 44, and also equatorially inclined. A portion detached from the extremity on the 8th, after which date it began to decrease, was broken up on the 10th, reduced to three small spots on the 11th, and to two, still smaller, on the 13th.

Apr. GROUP 46. *Long.* 213°. *Lat.* 5° S.
8–11. Some very small spots in two sets, chiefly composed of dots on the 11th.

Apr. GROUP 47. *Long.* 198°. *Lat.* 6° S.
10–14. A cluster of small spots, the p. at first with slight penumbra, in three sets on the 14th, forming a stream.

Apr. GROUP 48. *Long.* 185°. *Lat.* 4° S.
10–14. A pair of small spots; one only on the 14th.

Apr. GROUP 49. *Long.* 162°. *Lat.* 8° S.
10–11. Two or three very small spots, in a line with 48; on the 11th, one only.

Apr. GROUP 50. *Long.* 154°. *Lat.* 3° N.
16–18. A very small penumbral spot, a few dots f. rapidly disappearing.

Apr. GROUP 51. *Long.* 147°. *Lat.* 3° N.
18–21. A little stream, more vertical than is usually the case. Three of the spots larger on the 20th. The leader apparently severed.

Apr. GROUP 52. *Long.* 110° to 105°. *Lat.* 3° to 4° N.
20–21. Three little nebulous spots following each other, one dot on the 21st.

Apr. GROUP 52A. *Long.* 68°. *Lat.* 9° S.
24. A dot (observed only by Prof. Pereira).

Apr. GROUP 52B. *Long.* 45°. *Lat.* 14° S.
24. Another dot (Prof. Pereira).

Apr. GROUP 53. *Long.* 320°. *Lat.* 5° N.
24–26. A very small spot, hardly visible on the 26th (nearly the position of 38).

Apr. 29–May 1. GROUP 54. *Long.* 338° to 334°. *Lat.* 7° N.
Two little spots W. of the central meridian, widely separated; after April 29, one only.

Apr. GROUP 55. *Long.* 260° to 255°. *Lat.* 8° to 12° S.
29. A medium spot with double nucleus, penumbra confined to the p. side.
30. No details.
May.
1. Tapering and dividing eastward, a few outliers f.
2. Great increase, nucleus with six divisions, sharp, and at different angles to each other, more outliers, forming a tail-like appendage.
3. Still larger, nuclei more numerous, coalescing and curving chain-like at 12.30. At 5.45 p.m. more confluent. (*See* illustration.)
4. Elongating, five nuclei, major axis nearly 2′ of arc. A curved stream of small spots at the rear.
5. Signs of division, the nucleus p. bulbous in form, with a black hole, the f. elongated, somewhat resembling the vertibræ of a fish, outliers less curved.
6. Separation commencing at the rear.
7. Three principal nuclei, the central one lighter in colour, divided at the extremity and curving round.
8. Less complicated.
9. Smaller, three nuclei. Gaping at the extremity but not elongated.
10. Nearing W. limb. The whole spot seems to be bulging above the surface of the sun (Pereira). A few little spots to the S., and a stream of faculæ.
11. Near limb much decreased. Observed in the a.m. by the Rev. F. J. Eld. Not seen at 6 p.m. by Mr. Hadden.

Apr. GROUP 56. *Long.* 234°. *Lat.* 3° N.
30–May 12. A spot seen as a fine line near E. limb at 6 p.m. by Mr. Hadden. in nearly the same position as Group 41. Penumbra curving westward until after May 4th. Nucleus bridged on the 3rd, quadrangular on the 5th, a small portion appearing as if detached on the 9th and 10th. Few outliers. Major axis about 40″. It decreased a little in area.

May. GROUP 57. *Long.* 233°. *Lat.* 6° S.
2–4. A spot with slight penumbra, at some distance from E. limb on the 2nd.

May GROUP 57B. *Long* 148°. *Lat.* 8° N.
14. A very small black spot.

May GROUP 58. *Long.* 5° to 1°. *Lat.* 2° N.
19–26. A few very small spots observed near E. limb, at 11 p.m., by Mr. Hadden. On the 22nd a close pair; they seem to have increased a little in number, when last observed as a stream.

May GROUP 59. *Long.* 23°. *Lat.* 1° S.
20-24. At first only dots, then a cluster, increasing in number on the 22nd and decreasing afterwards.

May — GROUP 60. *Long.* 270°. *Lat.* 9° S.

26–June 6. A considerable spot. When near E. limb with penumbra nearly equal on both sides. For the most part normal throughout, major axis about 1′ of arc. Some outliers p. until June the 3rd. A black hole in the nucleus on May 27th. On the 30th, when only about 10° from the central meridian, the Rev. F. J. Eld observed it surrounded with a complete ring of faculæ, which appeared raised above it. Dr. Smart also observed a bright ring round the penumbra on the 27th. It was close to the W. limb at 6.5 p.m., and had vanished at 8 p.m. (Mr. Hadden, Iowa), on June the 6th. The penumbra was wider towards the limb on the 5th.

May — GROUP 61. *Long.* 238°. *Lat.* 16° S.

27-31. A spot with slight penumbra, near E. limb on the 27th. It showed a little increase; with two nuclei on the 30th, but was finally reduced to two dots.

June — GROUP 61A. *Long.* 103°. *Lat.* 22° N.

7. A black dot observed at 10.48 by Prof. Pereira.

June — GROUP 62. *Long.* 138° to 129°. *Lat.* 16° S.

12. At 9.13 a.m. some small nuclear spots in two sets N. and S. of each other, the one to the S. a tiny stream composed of 10 little spots close together. At 6.45, more divided, and with a little penumbra, both sets being now very similar. (Not seen at 11 p.m., on the 11th by Mr. Hadden).

13. The relative positions altered, much increase in area, the largest spot p. very compound, and changing rapidly, many sputterings between it and the f. spot at 6.10 p.m.

14. Two principal spots, both irregular, with numerous small nuclei.

15. Nearing W. limb, the f. reduced.

16. One spot, near limb at 9.15.

June — GROUP 62A. *Long.* 25°. *Lat.* 14° S.

13-15. A pair of very small black spots which did not increase.

July — GROUP 62B. *Long.* 289°. *Lat.* 11° S.

20–22. A small spot preceding Group 63.

June. — GROUP 63. *Long.* 272°. *Lat.* 8° S.

20–July. 3. A penumbral spot preceded by two very small ones in the midst of faculæ on the 20th. (A return of Group 60.) Major axis 35″. Penumbra on the 22nd rather wider on the f. side. Little change had taken place in area when near W. limb. On July 3 very close to it at 4.30 p.m.

June. — GROUP 64. *Long.* 344° to 351°. *Lat.* 9° N.

22-24. A wide pair of faint spots; more widely separated on the 24th.

June. — GROUP 65. *Long.* 179°. *Lat.* 4° S.

28. A small penumbral spot near E. limb.

29. A cluster in the midst of bright faculæ.

30. Spots larger, especially the leader.

July.

1. The p. spots forming one larger than the rest, with many small nuclei.

2. Leader with a portion detached, the rest all small.

3. F. spots disappearing.

4. Nucleus quadrangular.

5. More normal, solitary. Major axis about 35″.

6. Severed centrally. A few outliers.

7. A perfect pair.

8. Division wider, no outliers.

9. Northerly portion decreasing.

July. GROUP 66. *Long.* 116°. *Lat.* 10° S.

3–14. A few very insignificant spots on the 3rd and 4th, which coalesced on the 5th, forming one penumbral spot at least 30″ in major axis; afterwards normal; two nuclei on the 7th. When near the central meridian, circular, nucleus entire, gradually decreasing, and very small when near limb.

July. GROUP 67. *Long* 65°. *Lat.* 6° S.

6. A penumbral spot near E. limb at 4.20 p.m.
7. Nucleus divided. (The third single spot of much the same area visible at one time.)
8. Irregular, five nuclei.
9. Split in twain, each portion with only one nucleus.
10. The f. portion larger, not exceeding 30″.
11. Portions nearly equal and more widely separated; penumbra on opposite sides.
12. Near each other; three faint little spots at some distance f.
13. Again almost forming one spot; three nuclei.
14. The p. portion decreasing, nuclei splitting.
15. One spot, smaller.
16. Three dots in the midst of faculæ.

June. GROUP 68. *Long.* 156° to 159°. *Lat.* 12° S.

7–10. A small faint spot in the western hemisphere; on the 8th and 9th a stream, the leading spot only with slight penumbra; on the 10th one spot.

July. GROUP 69. *Long.* 99°. *Lat.* 11° S.

13–16. Another faint spot in the western hemisphere, increasing a little at 7.30 a.m. on the 14th, and more in number at 6 p.m. On the 15th, 30″ in major axis, with two nuclei.

July. GROUP 70. *Long.* 82°. *Lat.* 8° N.

13–16. A wide pair, not seen on the 14th either at 7.30 a.m. or 6 p.m., nor in Greenwich Record. On the 15th still very small and nearer each other. (Mr. Hadden also noticed their disappearance on the 14th.)

July. GROUP 71. *Long.* 8° to 4°. *Lat.* 6° S.

13–19. Another wide pair of small spots in the eastern hemisphere, first observed at 7.15 p.m. Two pairs on the 15th, more widely separated; a stream on the 16th, expanding in front on the 19th, again, a wide pair on the 18th.

July. GROUP 72. *Long.* 272°. *Lat.* 9° S.

19–22. At first a nebulous spot, on the 21st a little pair (a return of 63).

July. GROUP 73. *Long.* 258° to 259°. *Lat.* 3° to 6° S.

20. A penumbral spot near E. limb.
21. Three irregular spots, the largest about 30″ in major axis.
22. Two principal spots, with divided nuclei, increasing in area.
23. Penumbra now curved and segmented; outliers increasing.
24. Many small nuclei, still much subdivision.
25. Further increase. Both spots split lengthwise. Major axis of each 1′ of arc.
26. The p. closing up, a vacancy in the centre, with small nuclei round it. The f. opening eastward.
27. The p. consolidating, the f. fast decreasing.
28. The p. almost normal, the f. nearly gone.
29. Nucleus of p. with only one division. Almost solitary.
30. Shrinking, nucleus cloven to the S. at 4.45 p.m.
31. Penumbra equal on both sides, not far from limb at 6 p.m.

July. GROUP 74. *Long.* 244°. *Lat.* 12° N.

21–Aug. 1. A penumbral spot with double nucleus when first observed, entire on the 22nd August, singularly cloven on the 23rd, and closing up on the 24th, then normal. One or two small outliers after the 30th, when it was decidedly on the wane; major axis hardly more than 40″.

July. GROUP 75. *Long.* 200° to 198°. *Lat.* 8° N.

29–Aug. 1. A cluster of dots only, not seen at 10.30, but observed by Mr. Hadden at 1.10 p.m., then a miniature stream. On August 1st a dot barely visible.

July. GROUP 76. *Long.* 120°. *Lat.* 9° S.

31–Aug. 3. A very small spot surrounded with faculæ not very far from E. limb. A pair on August 1st, a still smaller spot f. With slight penumbra on the 2nd. A compact little stream on the 3rd, with no f. spots.

Aug. GROUP 77. *Long.* 68°. *Lat.* 6° S.

3. A large spot with irregular nucleus and deeply fissured, near E. limb at 7.30 a.m. A few small spots f. (A return of Group 67.)
4. Penumbra nearly equal on both sides.
5. Following spots larger. (*See* illustrations.)
6. Nucleus less fissured but more fimbriated, f. spots in close connexion, with a great amount of penumbra.
7. Major axis 1′ 12″. Nucleus still more fimbriated, f. spots quite detached from the leader and altered in position.
8. A portion of the nucleus separated from the main, radiations in penumbra clearly visible, f. spots smaller, some new ones to the N.
9. Near the central meridian, penumbra expanding to the E., f. spots rapidly decreasing.
10. Major axis 1′ 20″, detached portion re-uniting.
11. Penumbral expansion shrinking, f. spots few and scattered.
12. Penumbra streaming southwards but unbroken at 7.45 a.m., at 6.20 p.m., a portion detached.
13. More normal.
14. Near limb, penumbra nearly equal on both sides. Area differing little from ingress.

Aug. GROUP 78. *Long.* 42°. *Lat.* 16° S.

5–16. A small spot near E. limb on the 5th. Penumbra after the 6th chiefly on the S. f. side. Normal on the 7th. Two small spots far in advance and widely separated on the 12th.

Aug. GROUP 78A.

8–9. Two dots surrounded by faculæ near W. limb. One only on the 9th (observed by Mr. Hadden).

Aug. GROUP 78B. *Long.* 37° to 40°. *Lat.* 8° S.

12–16. A few little spots s. f. Group 78. More in number on the 13th, some with slight penumbra. On the 14th a double stream, but when near W. limb only two spots were visible.

Aug. GROUP 79. *Long.* 82. *Lat.* 6° N.

9. Two little spots N. p. group 77. One with slight penumbra.

Aug. GROUP 80. *Long.* 337°. *Lat.* 20° N.

10–11. A very small spot at some distance from E. limb on the 11th.

Aug. GROUP 81. *Long.* 299°. *Lat.* 3° S.

12–14. Hardly more than a dot.

Aug. GROUP 82. *Long.* 259°. *Lat.* 8° S.

15–27. A normal spot. (A return of group 73). Penumbra on the 17th a little wider on the f. side; major axis 30″ on the 18th at 11.50, on that date penumbra markedly transparent to the N. On the 20th nucleus quadrangular. After this a few small outliers were visible for a few days. When nearing W. limb it decreased rapidly.

Aug. GROUP 83. *Long.* 237° to 234°. *Lat.* 15° S.

22–23. About eight little spots close together, in two sets. On the 23rd only three widely separated, the two p. mere dots.

Aug. GROUP 84. *Long.* 221° to 219°. *Lat.* 8° N.

24–25. Another group of small spots in two sets; on the 25th at 5.40 a.m., one faint spot (observed by Mr. Hadden).

Aug. GROUP 84A. *Long.* °. *Lat.* ° S.

26. A wide pair of very small spots in the Western hemisphere.

Aug. GROUP 85. *Long.* 192° to 190°. *Lat.* 9° N.

26–28. A little pair not far from the central meridian. On the 28th much more widely separated.

Aug. 29–Sept. 11. GROUP 86. *Long.* 70°. *Lat.* 6° S.

A normal spot observed at 7·40 p.m. by Mr. Hadden as a mere line close to E. limb; penumbra nearly equal on both sides at both ingress and egress; nucleus at first somewhat irregular, afterwards normal, when on the central meridian, circular. A few small outliers which disappeared after September 2. (A return of Group 77.)

Aug. GROUP 87. *Long.* 83°. *Lat.* 4° S.

31. A dot p. 86.

Sept.

2. A few little spots widely separated.
3. Some new ones with dots N. f.
4. The p. almost gone, great increase in those to the N.
6. The p. quite gone. The others consisting chiefly of two normal spots forming (with 86), three at nearly equal distances.
7. The leading spot irregular, the f. tapering in front.
8. Both with divided nuclei.
9. Nearing limb; more normal.
10. The f. near limb almost obscured by faculæ.

Aug. GROUP 88. *Long.* 50°. *Lat.* 14° N.

31. A small penumbral spot near limb at 5 p.m.

Sept.

1. No penumbra E. or W.
2. A bridge, dazzlingly white, across the nucleus, now with three divisions.
3. Two nuclei and two small ones, as if ejected.
4. One nucleus, pear-shaped, sputterings to the S.
5. Nucleus divided, still elongated.
6. Still broken up at the extremity.
7. Major axis nearly 45″.
8. Breaking up on the N. f. side.
9. Decreasing, a sudden outburst of spots f. one penumbral.
10. Following spots smaller.
11. Still decreasing.
12. Near limb, no followers.

Sept. GROUP 89. *Long.* 39° to 22°. *Lat.* 9° to 11° S.

2. Some small scattered spots near E. limb, three only with penumbra.
3. Small nuclear spots p. closely connected N. and S. of each other.
4. Immense increase (at 8 a.m.). Two large spots, the p. with nuclei arranged crosswise and surrounded with penumbra, a few sputterings between. The f. nearly normal.
5. The p. with large nucleus in front and two or three smaller; the f. more circular, a cloud of small spots between them.
6. "Full of wonderful detail, a curious rectangular bridge across the nucleus of the p. cyclonic motion in the S. p. side of it" (Prof. Pereira). The f. spot also curiously bridged.
7. At 9.30 a.m. the p. very complex, large nucleus still in front, smaller ones at the rear, about 6 p.m. a rent took place almost cutting these off from the main. A tail-like wavy train of very small spots succeeding. The f. spot more regular. Some proper motion seems to have taken place about this time.
8. Still more complex, the rent closing up, the small nuclei very sharp and numerous, the train gone; f. spot breaking up.
9. The p. more elongated. At 2.30 a wonderful mass of sharp pointed nuclei at right angles to each other, in half an hour these points had disappeared. The f. spot semicircular with a swarm of dots in front of it as if an explosion had taken place.
10. Nuclei consolidating, portions at the rear quite detached.
11. Much altered, evidently on the wane.
12. One principal nucleus p. the f. more reduced.
13. Near limb, about four spots only.
14. The f. spot only seen.

Sept. GROUP 90. *Long.* 28° to 16°. *Lat.* 6° to 8° S.

6. A few small spots f. Group 89, in a little stream.
7. More in number and increasing in area.
8. Several with penumbra. The most easterly distinct from the rest; a forward motion in longitude seems to have taken place here.
9. Two principal spots, major axis 30″ and 20″, with only scattered dots between.
10. Both more normal.
11. Nuclei in both broken up.
12. The f. spot almost gone.
13. Near limb. Hardly more than one spot.

Sept. GROUP 91. *Long.* 32°. *Lat.* 12° N.

12–13. One or two small spots, with another much further S.

Sept. GROUP 92. *Long.* 295°. *Lat.* 7° S.

14–15. A small nebulous spot not far E. of the central meridian, only glimpsed on the 15th.

Sept. GROUP 93. *Long.* 244°. *Lat.* 5° S.

14. A few little spots in two sets in the eastern hemisphere.

Sept. GROUP 94. *Long.* 218°. *Lat.* 10° N.

15–21. A small spot, normal when near E. limb, but more irregular on the 16th, afterwards again normal; nucleus divided on the 19th, but with hardly any penumbra; several spots on the 20th, and a new one to the S. on the 21st.

Sept. GROUP 95. *Long.* 241° to 237°. *Lat.* 16° S.

17–21. At first one small spot without penumbra, afterwards a few more, lastly two, more widely separated.

Sept. GROUP 96. *Long.* 285°. *Lat.* 11° S.

19–20. Two very small spots in the western hemisphere; on the 20th one.

Sept. GROUP 96A. *Long.* 295°. *Lat.* 11° S.

20. A very small spot not far from W. limb. Nearly in the same position as 92.

Sept. GROUP 97. *Long.* 186° to 179°. *Lat.* 9° S.
20. A cluster with a leading penumbral spot. New since the 19th.
21. Leader in the form of a horse-shoe.
22. A train.
23. Leader normal, few spots f.
24. Nearly circular, the f. very faint.
25. Solitary.
26. Little change.
27. Nucleus double.

Sept. GROUP 98. *Long.* 143°. *Lat.* 12° N.
21–27. A small penumbral spot with one or two followers, nucleus double on the 22nd, and again on the 26th, otherwise showing little change. It disappeared before reaching the W. limb.

Sept. GROUP 99. *Long.* 147° to 141°. *Lat.* 5° N.
21. A small penumbral spot, area larger than 98.
22. A stream of smaller spots f.
23. Spots about five in number, with more or less penumbra.
24. More spots f., and spreading to the N. and S.
25. Still more dispersed.
26. Again more stream-like.
27. The f. spots all very faint.
28. Leader only a small spot, the f. nearly gone.
29. Only a dot f.
30. Solitary, normal.

Sept. GROUP 100. *Long.* 203° to 200°. *Lat.* 7° N.
23–24. Two or three little spots in the western hemisphere.

Sept. GROUP 101. *Long.* 214°. *Lat.* 8° to 10° N.
23–24. One or two very small spots preceding Group 100.

Sept. GROUP 102. *Long.* 72°. *Lat.* 6° S.
26–Oct. 8. A penumbral spot, major axis about 30″. Nucleus on October 2 divided by a narrow bright streak, re-united on the 3rd. (A second return of Group 77.) A few outliers s.f. on September 30.

Sept. GROUP 103. *Long.* 62°. *Lat.* 9° N.
27–Oct. 8. A penumbral spot attaining to 45″ in major axis. Nucleus bridged on September 30th, curving northwards and deeply indented on October 3, but normal after the 4th. A few small outliers on the 2nd only.

Sept. 30–Oct. 6. GROUP 104. *Long.* 37°. *Lat.* 14° N.
A small spot with slight penumbra, one or two smaller N. f. on September 30, and a few S. f. on October 4 and 5.

Oct. GROUP 104A. *Long.* 41°. *Lat.* 14° S.
4–5. A faint little spot near the central meridian, probably seen by Mr. Hadden as two small dots on October 1.

Oct. GROUP 105. *Long.* 328°. *Lat.* 1° S.
5–6. A small nebulous spot not very far from E. limb; on the 6th two.

Oct. GROUP 106. *Long.* 15°. *Lat.* 3° S.
7. A small dark spot preceded by a still smaller one.

Oct. GROUP 107. *Long.* 251° to 247°. *Lat.* 11° N.
10–13. At first two little spots; on the 12th rather more in number, but without any increase in area. On the 13th one only.

Oct. GROUP 108. *Long.* 233°. *Lat.* 10° N.
13–14. Two very small spots. On the 14th reduced to one.

Oct. GROUP 109. *Long.* 210° to 205°. *Lat.* 9° to 10° N.
16–19. A stream of small spots, the last somewhat nebulous, more scattered on the 17th, few and faint on the 18th. Prof. Pereira observed a tiny spot on the 19th at 6.18 p.m.

Oct. GROUP 110. *Long.* 177°. *Lat.* 5° N.
20–21. Three little spots, one only observed at 5.58 p.m. in the Azores.

Oct. GROUP 111. *Long.* 135°. *Lat.* 6° N.
20–25. A few very small spots; reduced to one, barely visible on the 24th and 25th.

Nov. GROUP 112. *Long.* 83°. *Lat.* 7° S.
1. A nebulous spot in the western hemisphere.

Nov. GROUP 113. *Long.* 359° to 354°. *Lat.* 10° S.
2. A very wide pair of small faint spots.

Nov. GROUP 114. *Long.* 304°. *Lat.* 11° S.
2–7. A small nebulous spot showing no increase, a dot p. on the 7th.

Nov. GROUP 115. *Long.* 194°. *Lat.* 8° S.
12–17. A small spot with a trail of dots f. half-way between the centre of disk and S.E. limb. First observed on the 12th, by Mr. Hadden, in the position of faculæ seen on the 11th, and probably again on the 17th. It was barely visible on the 15th.

Nov. GROUP 116. *Long.* 212°? *Lat.* 4° N.
19–20. A small spot near W. limb. The Rev. F. J. Eld observed forked faculæ following it on the 20th.

Nov. GROUP 117. *Long.* 177°. *Lat.* 5° N.
20. A pair; small, but quite distinct, observed only by the Rev. F. J. Eld.

Nov. GROUP 118. *Long.* 166°? *Lat.* 5° N.
22. A pair of dots lying N. and S. of each other in the midst of faculæ, about 50° W. of the central meridian; owing to cloudy weather they could not be traced to the limb.

Nov. GROUP 118A. *Long.* 74°. *Lat.* 9° S.
26. A very faint spot not far from the central meridian, probably the same described by Prof. Pereira as a tiny pair, and by Mr. Hadden as a few very small spots.

Nov. GROUP 119. *Long.* 350° to 340°. *Lat.* 6° to 8° N.
29. A small spot with slight penumbra, two little pairs f.
Dec.
1. Many spots in a stream, without penumbra, curving to the N. at the extremity.
2. Some increase in area.
3. The f. spots in a semicircle.
5. Great increase, a leading spot, 1′ of arc in major axis, two smaller compound spots f.
6. Leader normal, one of the f. broken up.
7. Leader little altered, one of the f. broken up.
8. The f. only visible at 12.30.

Nov. GROUP 120. *Long.* 334°. *Lat.* 8° S.
29. A very small spot in the eastern hemisphere.

Nov. 29–Dec. 2. GROUP 120A. *Long.* 314°. *Lat.* 10° S. Another equally small spot.

Dec. GROUP 121. *Long.* 272° to 280°. *Lat.* 15° S.
3. A cluster of very small spots. (Seen only by Mr. Bartlett on this date).
5. Two considerable spots, both compound.
6. The p. divided, the f. more normal.
7. The f. decreasing.
8. The p. with penumbra only to the W.
9. The f. almost gone.
11. One spot, much reduced.
12. Very small, faculæ f.

Dec. GROUP 122. *Long.* 257°. *Lat.* 1° S.
6. Two tiny pairs.

Dec. GROUP 123. *Long.* 238°. *Lat.* 9° N.
5 9. A small spot same distance from E. limb, with a little penumbra on the 6th, afterwards decreasing rapidly. A pair on the 8th.

Dec. GROUP 124. *Long.* 211° to 194°. *Lat.* 7° to 12° N.
6. A large normal spot near E. limb.
7. Bridged, more penumbral spots f.
8. Leader with large elongated nucleus, three principal spots f., two of of them to the N. with penumbra on opposite sides, the third streaming southwards.
9. Leader with nucleus dividing to the W.; the f. spots disintegrated; many small nuclei.
11. Leader bridged in several places, major axis 1′, f. spots coalescing, and very compound, with penumbra extending to the S.W. in a wavy line. Many small outliers. Rapid changes taking place. (*See* illustration.)
12. The f. spots in the form of a Y., nuclei more serrated, some penumbral patches dissevered.
13. Leader with a portion at the rear almost separated, f. spots again altered in form and position, and expanding to the S.
14. More subdivided. A scattered stream of faint spots 10° to the E, in Lat. 6° N.
15. Nuclei again more amalgamated, faint spots hardly visible.
16. Four or five penumbral spots.
17. Some new small spots f. Faculæ very extensive.
18. Whole group more disconnected.
19. Leading spot vanished at 12.49. The f. close to the limb. Spot to the S. with penumbra on the p. side.

Dec. GROUP 124A. *Long.* 219°. *Lat.* 5° N.
11–12. A few very small spots, p. 124.

Dec. GROUP 125. *Long.* 302°. *Lat.* 14° N.
8. A pair of small spots, some distance apart.

Dec. GROUP 126. *Long.* 174°. *Lat.* 2° N.
14–15. A little pair S. f. 124. On the 15th a dot only.

Dec. GROUP 127. *Long.* 100°. *Lat.* 3° N.
15. A faint spot near E. limb.
16. Small.
19. Larger. Nucleus pointed on the f. side.
20. Slight penumbra.
21. Nucleus dividing.
22. Smaller, nucleus double.
23. Still decreasing.
24. Very small.

Dec. GROUP 128. *Long.* 312°. *Lat.* 15° N.

26. A small penumbral spot near E. limb.
28. Normal, three f.
29. Little change.
31. Major axis 35″ a small nucleus detached from the chief one, f. spots very faint.

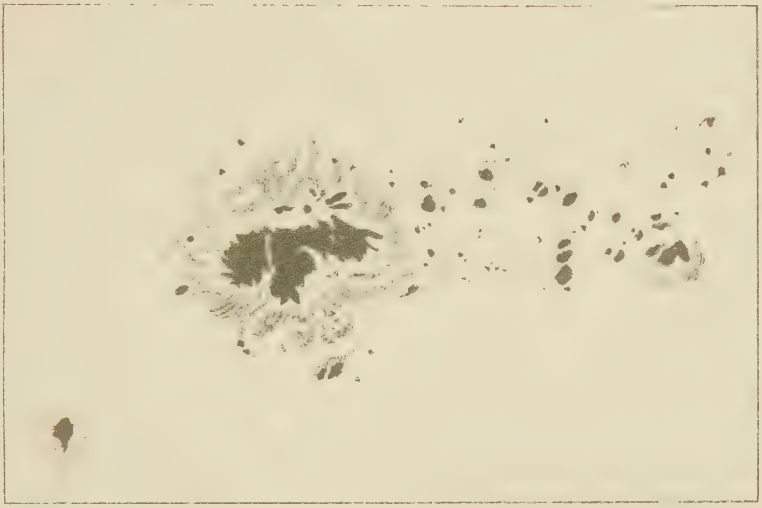
Dec. GROUP 129. *Long.* 8° to 10°. *Lat.* 9° S.

29–31. A cluster chiefly composed of dots. Three little spots on the 29th.

Dec. GROUP 130. *Long.* 269°. *Lat.* 7° N.

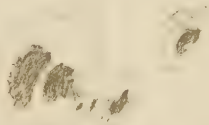
29–31. A small normal spot near E. limb, breaking up on the f. side on the 31st.

GROUP V. and VI. 1897.



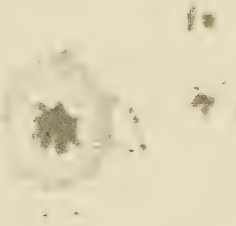
S.

GROUP XIX. (Return



Jan. 31. 2.P.M. (Direct vision) H.Corder del.

GROUP XX.



Feb. 17. 12. J. Wykes. del.

GROUP XXIII.

[illegible] E. B. del.

Mar. 2. 9.50 [illegible]

GROUP XXX.

Mar. 15. 12. E. B. del.

Mar. 16. 9. 50 [illegible]

GROUP LV. 1897.

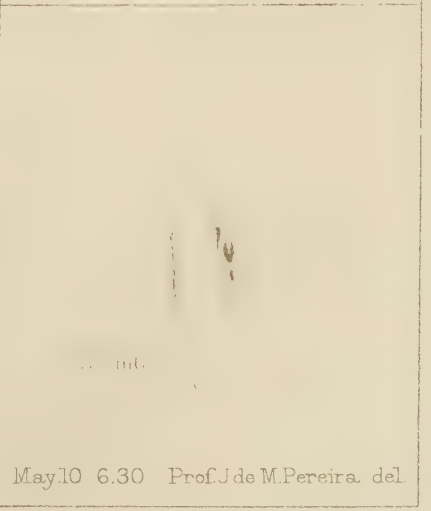
Apr. 29. 3.15. E.B. del.

May. 2. 11.30. E.B del

May. 3. 12.30. E.B. del

May. 3 5hrs later. E.B del.

May 6. 9.15 J. Bartlett del.

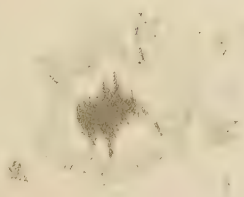


May 10 6.30 Prof. J de M. Pereira. del.

Aug. 3. 9. 48. J. de M. Pereira. del.

Aug. 5. 9. 50. A. M. J. de M. Pereira.

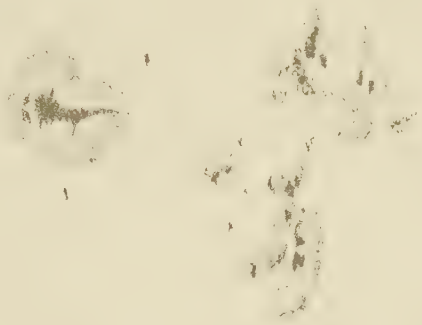
Aug. 8. 11. 0. J. de M. Pereira. del.



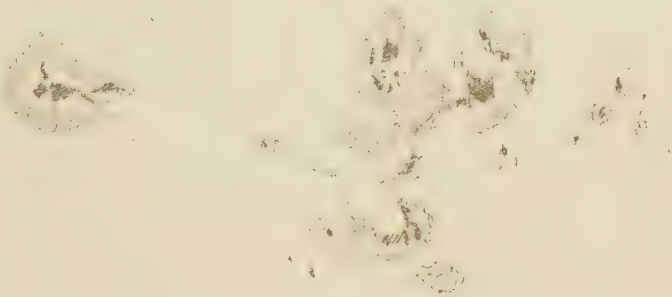
Aug. 11. 3. 0 E. B. del.

Aug. 14. 5. 20. J. de M. Pereira. del.

GROUP CXXIV. 1897.



Dec. 9. 10.45.



Dec. 11. 11.30

Dec. 14. 12.

(By Projection. Sun's image 25^{in} diam.)

E Brown del.

SECTION FOR THE OBSERVATION

OF

THE MOON.

DIRECTOR.—WALTER GOODACRE, F.R.A.S.

FOURTH REPORT OF THE SECTION.

Introduction.

The lamented death of Mr. T. G. Elger, F.R.A.S., the former Director of this Section, has left a gap in the ranks of selenographers, which still remains to be filled. The present Director has endeavoured to pursue the lines he so ably laid down, simply adding to the same such new features as have been thought desirable. Amongst much excellent work that has been done by a restricted number of observers, mention must be made of the report on Ptolemaus by Mr. S. A. Saunder, M.A., F.R.A.S., of Wellington College. Micrometrical measurements of the positions of some of the objects on the floor of this interesting formation were made by Mr. W. H. Maw, F.R.A.S., and the results are given in the second report of the Lunar Section. Mr. Saunder's report, which is the result of two years work, shows that comparatively little now remains to be done. When he has completed his labours, results will have been attained which, from a selenographical point of view, will be as valuable as they are unique. The Director also wishes to express his indebtedness to those Members of the Section who have from time to time sent notes and sketches, and in particular to Capt. P. B. Molesworth, R.E., F.R.A.S., for the opportunity freely given to make use of his volumes of notes on lunar formations and the beautiful drawings accompanying them; several references to these occur in the following pages.

The time that has elapsed since the publication of the Third Report of the Lunar Section has not been wasted, as the present report will show, and whilst no remarkable discoveries (from the nature of the case) have been made, valuable progress has resulted in several directions, and points of doubt existing in relation to certain lunar objects have been cleared up. The detail shown in the illustrations and the descriptive matter given in this report, it is felt, cannot but be of great value to future cartographers of lunar surfaces.

Photography in connexion with the lunar surface continues to make progress, and some really excellent negatives have been secured by one of our Members, Mr. J. M. Offord, F.R.M.S., specimens of whose work have recently been brought before the

Association. The Director would also like to call attention to the issue of Vol. I. of Herr Krieger's "Mond Atlas," the 28 beautiful maps which comprise the first volume are apparently based upon photographic enlargements, the minor details on which have been filled in at the telescope. They will repay careful study by all interested in selenography. The many admirers of the late Mr. T. G. Elger will note with pleasure that Herr Krieger seeks to perpetuate his memory by naming a formation after him—"Elger" is the imperfect ring-plain *f*, S.W. of Ramsden on Neison's map.

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CARR, Rev. Canon, F.R.M.S., &c., Holbrooke Hall, near Derby. 4½-in. O.G.

CORDER, H., Sunnyside, Bridgwater. 6½-in. Spec.

ELLIS, H., Potters Bar, N. 6-in. O.G.

FREEMAN, A., Hastings.

GOODACRE, W., F.R.A.S., Crouch End, N., *Director*. 12-in. Spec.

HALLOWES, G. P. B., F.R.A.S., York.

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HODGE, R., 75, Mount View Road, Stroud Green, N. 8½-in. Spec.

HUGHES, Rev. J. G., Maldon, Essex.

HUTCHINGS, Rev. R. S., F.R.A.S., Alderbury Vicarage, Salisbury. 12¼-in. Spec.

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MOLESWORTH, Capt. P. B., R.E., F.R.A.S., Trincomali, Ceylon. 12¼-in. Spec.

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SMART, D., M.R.C.S., F.R.A.S., 108, Grange Road, S.E. 10-in. Spec.

SMITH, C. F., Edinburgh. 5¼-in. Spec.

SMITH, Harold F., Wandsworth Road, Luton. 3½ in. O.G.

STRAKER, Donald, Oakleigh Park, N. 9½-in. Spec.

SAUNDER, S. A., M.A., F.R.A.S., Crowthorne, Berks. 7-in. O.G.

WADSWORTH, Rev. Henry, F.R.M.S., Forest Road, Coalville East, nr. Leicester. 8½ Spec.

Aristarchus and Herodotus.

Sketches have been received from Capt. Molesworth, dated 1892, November 1, and 1897, September 21, October 20, October 21; also a note on the Great Winding Valley, from Rev. T. H. Foulkes, M.A., dated 1897, October 22. The Director has also made sketches and notes, dated 1898, March 5 and 6.

In Capt. Molesworth's sketches of 1897, September 21 and October 21, the polygonal form of the inner walls of Aristarchus is well shown, and in the accompanying notes Capt. Molesworth records a very unusual appearance. The crater was at that time (September 21) just before sunset filled with shadow, and the inner terraces, which should have been invisible, were seen as faint knotted glimmering streaks under both E. and W. walls, and the central peak was also dimly discernible. Captain Molesworth suggests phosphorescence produced by long exposure to the sun's rays, or from inherent heat, or reflected glare from the western rampart, as possible explanations of this appearance. The interior and surroundings of Aristarchus seem to call for the most careful and constant observation; the Director has on more than one occasion seen what appears to be a faint bluish mist on the inner slope of the E. wall soon after sunrise, which was visible only for a short time. Capt. Molesworth has also seen the same appearance, which, he thinks, cannot be fancy or the result of contrast. Another curious feature exhibited by this crater, and which does not appear to be previously recorded was seen by the Director on 1896, March 6. At this time the floor of Aristarchus being free from shadow, several faint parallel dark streaks were seen crossing the floor and E. wall. Herr Krieger, in his beautiful map of Aristarchus and Herodotus, drawn 1897, April 14, depicts a similar appearance, except that he shows the streaks radiating from a centre instead of being parallel. The Rev. T. H. Foulkes has seen a dark streak crossing the southern part of Herodotus, which is possibly an extension of one from Aristarchus.

The Great Winding Valley, which is so closely associated with Aristarchus and Herodotus, has claimed a good deal of attention by some of the Members of the Section. It has always been a moot point among selenographers whether or not this valley terminates on the interior of Herodotus or outside its northern rampart. Neison and Elger held the former view, and Herr Krieger's map supports them. Prof. Pickering, as the result of his Arequipa observations, maintains the latter view. The Rev. T. H. Foulkes says, that from observations extending over a long time, there is no connexion between the gap on the N. wall of Herodotus and the S. end of the Winding Valley. The Director examined this object under favourable conditions in 1898, March 5 and 6, and the sketch then made (Plate 1.) fully bears out Mr. Foulkes' assertion. The Great Valley was seen to terminate abruptly in a distinct pear-shaped crater pit at about 10 miles from the N. wall of Herodotus, no extension of this valley beyond the crater was discernible, though carefully looked for. From this crater-pit the ground rises gradually, forming a rounded hill whose S. side slopes away to the N. wall of

Herodotus; the hill is very dark in tint, very similar to the dark spots in Atlas; some little distance to the E. of the crater-pit, in which the Great Winding Valley terminates, is a short cleft, but quite apart and disconnected with the Great Valley; its proximity, however, may have caused some observers to have regarded it as a continuation of the Great Winding Valley, and to the conclusion that it debouched on the floor of Herodotus.

Atlas.

Considerable interest has been aroused in connexion with this fine ring-plain in consequence of the discovery of the variation in intensity of colour of the two well-known dark spots, situated one at the N. end and the other at the S. end of the interior. The variability of the S. spot was first noticed by Elger in 1870–1, and Prof. Pickering, as the result of observations at Arequipa in 1891, has confirmed this fact, whilst Mr. Stanley Williams's observations, made in 1883–7, have enabled him to deduce a light curve for both spots; the details of Mr. Williams' results have already appeared in the "Journal" (Vol. 8, No. 5). From each of these spots there appears to emanate a series of rills. Webb mentions having seen several rills, but gives no particulars. Neison refers to two, one seen by Webb, and the other by Gaudibert, these have often been seen since, and are not difficult objects under a suitable angle of illumination. Capt. Molesworth has submitted a fine sketch of Atlas (Plate I.), showing these two rills η and ϕ, and several others in addition, which are now published for the first time.

The small crater near the centre is probably the one discovered by Schroter, and seen since, but missed by Mädler; one distinct crater on the floor at the N. and three crater-pits near to it do not appear to have been recorded before. There is an enormous amount of fine detail on the floor of Atlas, which will amply repay careful examination with telescopes of large aperture.

Cassini.

A fine sketch of this crater, by Capt. Molesworth, has been received; it is dated 1892, Nov. 27, and is notable as showing more detail on the floor than recorded by either Neison or Elger. In the 3rd Report of the Lunar Section is a record of the observations of Herr Brenner, in which he states that he has found three small hills where two only have been seen before. Capt. Molesworth only shows two, he, however, shows one N. of the crater *b*, which may be one of the three referred to by Herr Brenner. Capt. Molesworth also shows Brenner's rill, between A and the W. wall, with several ridges near, also a small hill between this rill and the foot of the W. wall; he also shows a small crater N. of A, and close to or on the N. wall; this has not apparently been recorded before, but its existence is confirmed by Herr Krieger who shows it in the map of Cassini, which appears in Vol. 1 of

his "Mond-Atlas." This map is based on an enlarged photograph of this formation, the finer detail apparently having been filled in as revealed by his 10½ Zölliger refractor. The close agreement between Capt. Molesworth's drawing and Herr Krieger's is remarkable, and completely testifies to Capt. Molesworth's accuracy and skill as a delineator of the lunar surface.

Cepheus.

This interesting formation has been sketched by Capt. Molesworth, and he shows in place of the small central elevation mentioned by Neison and Elger, a well-defined crater-pit, the sketch also shows a white spot on the N. side of the floor, a hollow at the foot of the S.W. wall, and a large ridge at the foot of the E. wall, with a horseshoe-like formation near the S.E. wall, giving the appearance of a ruined crater-ring. None of these objects are shown by Neison or Elger.

Cleomedes.

This is another formation which has been sketched by Capt. Molesworth, 1896, May 29, with the result of recording several features for the first time. His sketch shows a system of rills on the floor, mostly running from S. to N., terminating at the N. end in a cleft running from N.E. to S.W.; this latter is said to be an easy object, but the other rills are evidently fairly difficult to see except under specially favourable circumstances, as the Director, who has given considerable attention to the floor of Cleomedes, has, so far, failed to see any of them. Neison and Elger make no reference to any rills. Neison mentions that the E. wall contains several craters, but though this wall has been seen by the Director when close to the terminator several times no craters have been found. Neison also mentions a pass on the W. wall which has not been seen; there is one, however, in the S.W. wall which possibly may be the one in question; he also records three craters at the foot of the inner slope of the N. wall, but Schroter and Lohrmann only saw two, and this is all the Director has been able to see after the closest scrutiny under best conditions. It is much to be desired that Members with large apertures should give attention to these details so as to clear up the discrepancies now disclosed. At the N.E. end of Cleomedes the small ring-plain, Trailles, intrudes its S.W. wall into the interior of Cleomedes; at the foot of the S. wall of Trailles, and on the floor of Cleomedes, the Director has detected a crater-like object, when Cleomedes was on the evening terminator, and he noticed at the same time a cleft cutting through this S.W. wall of Trailles from the interior of Cleomedes, 1898, October 31.

Craters between Reinhold and Landsberg.

In 1879, Birmingham discovered a small crater nearly midway between Reinhold and Landsberg, and a little to the S. of the ridge marked on Neison's map. This crater is not shown by Lohrman, Mädler, Schmidt, Neison, or Elger. The Members of the Section were asked to search for the missing crater on every opportunity. This search has resulted in its being found again, and also in the recording of several small craters and hills in the same neighbourhood whose positions, together with that of Birmingham's crater, have now been determined with fair accuracy. Birmingham's crater was found in the position he ascribed to it, and is a fairly easy object when the morning terminator is at W. wall of Landsberg, but its visibility is evanescent.

The sketch (Plate II.), was made by the Director 1898, April 30, at 10 hours. There are two minute hillocks close to the W. wall of Landsberg; the crater B just S. of the curved ridge is Birmingham's; within the horns of the ridge is a hillock, which might easily be mistaken for a crater cone, but has no depression on its peak; between the curved ridge and Reinhold are several small craters. These objects were first seen by the Director on 1898, March 2, and are also shown on a sketch received from Mr. R. Hodge, dated 1st April 1898.

Copernicus.

Mr. C. F. Smith sends a fine pencil drawing of Copernicus made 1898, March 2, 8^h to 10^h (Plate I.), which compares well with the drawing, given in Neison's "Moon," of this formation, but shows certain important differences in the detail it exhibits, the sketch also shows well the polygonal shape of the interior walls.

In an interesting observation made by Capt. Molesworth, dated 1896, May 5; he saw during moments of fine definition, a delicate rill running a short distance from the central mountain in a southerly direction, half-way towards the S. wall, when it suddenly turns to the E., and reaches the rampart; he also saw at the same time a small crater at the foot of the inner slope of W. wall. Neither of these two objects appears to have been recorded before.

Egede.

This small lozenge-shaped ring-plain, has received very little notice from selenographers, it is remarkable, not only for its peculiar shape, but for the lowness of its walls, which apparently do not exceed 400 feet in height in any part. They are, therefore, only visible when less than 15° to 20° from the terminator.

Capt. Molesworth sends a sketch, dated 1892, July 31, showing that the walls are broken down to the level of the plain on the E. side; also on the N. side, where, for a considerable distance only isolated hillocks and ridges remain; at the S. end is a broad pass or funnel-shaped opening to the surrounding plain, one crater-pit is shown on the S.W. wall, another close to a ridge

inside the N. wall, and four smaller pits under inside of the W. wall. Several small craters are also depicted outside the walls on the N., S., and W. sides.

Herr Krieger, in his recently published Mond-Atlas, Vol. I., has a drawing of this formation which shows several important differences when compared with Capt. Molesworth's sketch.

Herr Krieger omits the four small crater-pits under the W. wall. He, however, shows a double crater-pit on the gap on the N. wall, where Molesworth only shows a small hillock. It is difficult to understand how Capt. Molesworth could have overlooked this twin crater if it is as prominent as Herr Krieger depicts it. On the S.W. wall, Capt. Molesworth draws a crater and a smaller one close to it, but on the floor, neither of which is on Herr Krieger's map, unless the double crater is intended for them. The positions on each map vary, however, to such an extent that this seems hardly possible.

Endymion.

Mädler and all later selenographers show the surface of this formation as being *quite smooth and free from detail of any kind*; only Schmidt records two low ridges of considerable length in the interior. The Members of the Section have had this object under observation for some time past, and the following interesting results have come to hand. Capt. Molesworth sends a sketch dated 1894, April 21, on which occasion he was fortunate enough to see the following detail on the floor.

Four craters almost in a line near the N. end of floor and running N. to S.

Three white hillocks under the E. wall, and at almost equal distances from each other. A small depression under the W. wall, and about half way between the N. and S. ends.

Seven white spots, and several longitudinal white ridges or markings connecting most of these spots, and apparently bearing the same relation to them as exists between the light streaks and spots on the floor of Plato. One of these spots, which he marks No. 5 on his sketch, he states to be the most prominent object on the floor. It is situated slightly S. of the centre and equally distant from the E. and W. walls.

Mr. R. Hodge, in an observation made 1898, October 31, records a distinct longitudinal ridge elevated at the ends, and apparently broken or discontinuous at the middle.

Mr. Donald Straker, also observing on the same date, reports seeing a streak running obliquely across the floor from N.W. to S.E., and two bright spots on its S. margin near the centre of the floor, also a fainter streak running from this oblique marking to the foot of the N. wall. It would appear that this streak is the same as shown by Capt. Molesworth, and on which his four crater-pits are situated.

It will be seen from the above that Endymion will amply repay the most careful and continuous study by those who possess telescopes of fairly large aperture. All the foregoing observations were made when Endymion was near the evening terminator.

Gassendi.

Two very fine drawings of Gassendi by Capt. Molesworth have been received, they show many of the delicate rills which exist on the floor, some of which are exceptionally difficult objects to see, also a number of craters and mounds; a comparison of these drawings with the one figured in Neison's "Moon" reveal many points of agreement as well as of differences; a much longer study, and by more observers with telescopes of adequate power is requisite to do full justice to the multitudinous detail on the interior of this formation, which Elger justly describes as one of the most beautiful telescopic objects on the moon's surface.

Hesiodus.

We are again indebted to Capt. Molesworth for a beautiful drawing of this object made 1894, May 14. It shows that the large crater described by Neison as being on the outer slope of the N. wall is really at the foot of the *inner* slope; it also shows the well-known central crater missed by Mädler, which is very strange unless it has become more conspicuous since, and it further shows a small distinct crater to the W. of this, seen by Schmidt, but not referred to by Neison or Elger. Capt. Molesworth also depicts some hillocks close to the Wall at the E. end of the floor not recorded by any of the above mentioned authorities. This sketch also shows that Hesiodus A has a small previously unrecorded crater on its W. wall.

Linné.

This object was seen by the Director 1898, February 27, as a bright hillock casting a slight shadow, but without any crater-like depression on its summit, it was situated on a small greyish surface marking, which gave the impression of being a shallow saucer-like depression.

Macrobius.

The Director observing this crater on a recent occasion when the interior was nearly filled with shadow at sunset, the inner side of the west wall being very bright; there was seen a distinct penumbral fringe to the black shadow cast on it by the E. wall; it was best seen when using high powers.

The Director has also seen a similar light chocolate penumbral shade edging the black shadows on the W. wall of Humboldt, when on the evening terminator (1897, December 9); similar appearances have been seen at various times and by several observers. The explanation of this phenomenon is difficult; it almost suggests the existence of some kind of vapour in the interior of some of these craters; in any case, all such appearances should be carefully examined and recorded.

Maclear.

A small though conspicuous ring-plain of about 16 miles in diameter. It has often been doubted if Maclear has a central hill. Schmidt, Lohrman, and Mädler show none. Neison only records a central greyish marking, there appears, however, now no question but that a low central hill does exist.

Miss Ashley, a well-known observer, has, according to the Selenographical Journal, seen a central hill on two occasions, 1879, October 4 and 5, and since then, in a note to the Director, she again mentions having seen it, 1881, December 10. The Rev. J. H. Foulkes, M.A., on 1897, November 2, saw a distinct hill with a blurred shadow on the *f.* side, and he is of opinion that the hill has a saucer-like depression on its summit.

Mr. W. J. Hall sends a fine sketch of this object, which is now reproduced (Plate II.), made 1898, September 5, showing the central hill and the curious shape of the surrounding walls as they are seen just before sunset; the light spot on S.E. wall is probable a peak.

Marius.

Beer and Mädler state that Marius possesses no central mountain, and they neither draw nor mention any other object on the floor, though they appear to have given considerable attention to it. Schroter, however, mentions a flat convex central elevation and also draws on S.W. wall a minute craterlet, which, Neison says, has not been seen since, and that probably Schroter was mistaken in thinking it existed. Unless some change has taken place in this formation since B. and M's. time, it does not appear that their examination of the floor could have been so critical as is suggested, seeing there is on the N.W. of the floor and close to the wall a very distinct craterlet discovered by Webb, and which is now a comparatively easy object. The low central hill has also been frequently seen since; Elger records the certain existence of four objects on the interior, (1) a crater on the N.W., (2) a white spot just S. of the centre; (3) a small spot just S.E. of this, (4) and another near the inner foot of the S.W. wall; all these objects, it is believed, have been confirmed. A sketch by Capt. Molesworth, dated 1896, August 21, shows eight objects on the floor. (Plate II.). No. 1 is the well-known crater on N.W floor. No. 2 is probably the missing crater of Schroter. This crater is also shown on a sketch by the Director (1887, December 6), and Mr. G. P. B. Hallowes shows it on a sketch, dated 1887, July 2; both these sketches also show an additional crater on the S.W. wall, a little to the S.E. of No. 2. The Director has also seen two other objects, probably craterlets, on the outside of the rampart, one N.E. and the other on the S.E.; the latter is shown, though not as a crater by Mr. W. H. Maw on a sketch, dated 1887, November 29.

Mare Nectaris.

On an excellent photograph by Mr. J. M. Offord, taken when this object was near the evening terminator, some curious concentric ridges or faults are plainly shown apparently indicating the successive levels of matter originally liquid which forms the bed of this "sea." In connection with these ridges, the Director saw, 1897, December 28, a small circular depression in the centre of the Mare Nectaris, and roughly concentric with the above mentioned ridges; the depression forms the lowest part of the surface of the Mare, and may be the spot from which the supposed molten matter was ejected which has destroyed the seaward walls of so many of the ring-plains bordering on the Mare.

Messier and Messier A.

These craters have been objects of continued interest since Webb in 1855-56 called attention to the dissimilar appearance they then presented to the drawings and descriptions of Mädler. Since the Members of the Lunar Section commenced to give them special attention several interesting drawings have been received. These craters vary very much in appearance according to libration, and the angle of illumination at the time of observation; this variation, is well shown on two sketches, one by Capt. Molesworth, made 1892, July 28, showing the craters under morning light, and the other by Mr. E. A. Attkins, made 1898, September 3 before sunset. There are several delicate crater-pits near to A. which can only be seen with fairly powerful telescopes and fine definition. A further sketch from Mr. Attkins has been received, dated 1898, October 1, showing Messier and Messier A, near the terminator at sunset (*see* Plate 1). The sketch depicts on the interior of Messier, a rill or ridge running centrally across the floor from E. to W. This feature does not appear to have been previously noticed, except by Herr Krieger, who shows it in the map of this district in his Mond-Altas, Vol. I., drawn under a slightly lower angle of sunlight. In Messier A, Mr. Attkins depicts a very interesting feature, namely, a crescent-shaped ridge under the inner E. wall, which casts a narrow shadow. This ridge is probably a continuation of the spurs on the S.E. and S.W. walls mentioned by Elger as having been first seen by Schmidt. Capt. Molesworth's drawing shows these spurs, which are also shown in Mr. Maw's sketch in the last report of the Lunar Section (Plate V.). This inner ridge is shown by Mr. Attkins for the first time, as continuous in its entire length. In Herr Krieger's map, already referred to, spurs are shown projecting into the interior of Messier A from both the N. and S. walls, but they fail to meet in the centre. In Mr. Attkins' sketch are shown a number of crater-pits and white spots, these all appear on Herr Krieger's map, except *f*, *h*, and *j*. Herr Krieger shows *e* and *g* as craters; he also shows 1 as two small craters in contact, and another small crater close to the N.E. wall of 11. No crater-pits are shown within some distance of the W. wall of Messier, or to the N. and S., except *b*. The floor of Messier A was noticed to be darker than that of Messier. Mr. A. A. C. E. Merlin has seen 1, 2, and 3.

Obscure and Partially Destroyed Ring-Plains.

All existing charts of the moon show very few of the traces of these more ancient features of the lunar surface, and scarcely any reference is made in the written description accompanying the same. It has been thought that some attempt should be made to record these interesting features, and the following details show what has been accomplished in a preliminary effort; large numbers exist in addition to those referred to in the plates, Nos. III. and IV. Some of these objects now depicted are well known, and form good examples of a much larger number whose existence is easily overlooked, and can, as a rule, only be seen for a very brief time when the terminator is close to them. In some cases all that remains of the original walls are a few isolated hillocks or mound-like ridges, probably under 500 feet in height; of this latter class Stadius is a well-known example; some of these formations are already designated by names, but others have been marked only with a letter for the purpose of rendering their identification more easy and certain, and this task is further simplified by the inclusion of some well-marked crater or ring-plain, which is usually associated with them; the dotted lines in each case show the position of the original ramparts, of which little now remains. It may be mentioned that the positions of these objects and their dimensions are only approximately correct:—

Plate III., Fig. 1. — Shows Le Monnier with its E. wall destroyed, probably by some action or force emanating from the M. Serenitatis. The most interesting member of this group is that lettered A, a remarkable ring-plain on the E. of Posidonius and slightly larger in size; whose walls S., S.E., and S.W., have been razed nearly to the level of the Mare, and the remains of which can only be seen with difficulty.

Fig. 2.—Shows four obscure formations to the S.E. of Ptolemaus. G is a partially destroyed formation shown on Neison's map and marked *c*. H is a larger and more irregular inclosure. J has much broken walls, and really forms a bay in H.

Fig. 3.—B and C. Two ring-plains, of the walls of which there remain only a few isolated hills.

Fig. 4.—Near Encke, and on the border of Oceanus Procellarum, are the remains of four obscure ring-plains, Encke itself being situated on the margin of the one marked D; of those marked G and F, the remaining walls are very low and only visible when near terminator.

Fig. 5.—Lubiniezky is shown by Neison and Elger to have walls intact, but they are broken down on the S.W. side, the round obscure ring-plain H is only well seen near terminator, I has a crater on the S. rim, which renders it easy of identification. Bonpland and Frau Mauro are too well known to need more than mention.

Fig. 6.—Shows some interesting objects of this class near Atlas and Hercules; J is not mentioned by Neison or Elger. M., seen

with difficulty, is about the size as Hercules, and not mentioned by Neison or Elger. N probably shown by Neison.

Plate IV., Fig. 7.—Near Jansen are two incomplete ring-plains *a* and *b*, only *b* is slightly indicated on Neison's map.

Fig. 8.—S. of Maraldi are three obscure ring-plains, two of which, *a* and the one to the south, have incomplete walls.

Fig. 9.—Shows the well known inclosure E. of Burg. To the S. is a most interesting object, *e*, of whose original walls only a chain of hillocks exist on the W. side, and two crater cones on the E. side; there are also three hillocks in the centre, which are now all that remain of what was once a massive mountain.

Fig. 10.—Flamsteed stands on the south rim of a large ancient ring-plain whose walls are now represented by low ridges broken in many places, *j* and *k* are practically obliterated except in parts; *g*, *h*, *i*, *j* are not shown on Elger's map.

Fig. 11.—There are several obscure ring-plains N. of Ptolemaus, some only of which are shown on existing maps.

Fig. 12.—There are three very faint ruined formations N.E. of Frau Mauro. *v* has totally disappeared, except isolated peaks, which occupy the position of the original ring; *w* and *x* are very similar, except that *w* appears to have intruded on the floor of *v*; in the centre of *v* there are some low elevations, evidently all that now remains of what was once a large mountain.

Fig. 13.—W. of Bullialdus are some very imperfect rings, of which nothing remains but discontinuous portions of the original walls. One is a complete ring, but the walls are almost reduced to the level of the plain, and could easily be overlooked.

Fig. 14.—Is one of the most interesting of the series, and records an observation made by Mr. C. F. Smith, 1898, January 9th, and shows a number of oval light markings on the surface of Sinus Iridum, which gave a strong impression that they are the remains of once prominent ring-plains, whose walls have been overwhelmed by the matter which forms the present surface of this portion of the moon.

Posidonius.

This is a magnificent ring-plain in the N.W. Quadrant, and is interesting because of the inner ring concentric with the outer walls, and for the system of delicate rills found on its floor. On none of the maps extant are these rills shown in their entirety, and there still remains much work yet to be done in adequately figuring the wealth of detail on its surface. Drawings by Capt. Molesworth, Rev. A. Mackay, M.A., and the Director have been received. Capt. Molesworth's drawing dated 1894, September 10, is now reproduced (Plate II.). The well-known longitudinal rill is distinctly shown, also the cross rill at S. end of floor. At the foot of the cross-like figure, formed by the two above-mentioned rills, is a delicate rill extending nearly to the E. wall, which is only suggested in the drawing, it is shown more distinctly in another sketch by Capt. Molesworth of an earlier date.

The Director's sketch also shows it, and Elger also records its existence, but Neison only its western half. There are many hillocks on the floor, and small craters shown by Capt. Molesworth, and mostly confirmed by Rev. A. Mackay, and which do not appear on the maps of Neison or Elger. From the central crater running N. to the inner wall, Rev. A. Mackay shows a delicate rill, which Capt. Molesworth confirms in his second sketch, who also shows another rill running from this crater in a S.E. direction and terminating at the inner wall just mentioned.

The well-known rill running E. to W. across the S. end of Posidonius is in reality a broad valley-like depression, and cuts through two considerable hillocks on its way, giving the appearance of a railway cutting; the interesting appearance noted by Schroter, who, on several occasions, found the central crater in Posidonius free from shadow, when it should have been full, and which was also seen to be the case by Gruithuisen (1821, April 7), has not been noticed by any Member of the Section. The various drawings to hand all showing a normal shadow in its interior.

Lunar Rills.

As yet no formal attempt has been made by Members of the Section to deal exhaustively with any of the various known systems of rills. A good number of sketches, however, have been received from Capt. Molesworth, who has given special attention to these objects, and they will form a most valuable basis upon which to work when observations by Members are seriously entered upon. Amongst the sketches to hand from Capt. Molesworth may be mentioned—

Rills near Guttemberg, 1892, May 1.
„ „ Cauchy, 1892, July 30.
„ between Sabine and Plinius, 1892, July 30.
„ near Ramsden, 1892, November 29.
„ between Sabine and Silberschlag, 1892, August 14.
„ N. of Menelaus, 1892, August 14.
„ between Gassendi and Mersenius, 1892, September 3.
„ near Plinius, 1891, February 14.
„ near Triesnecker, 1892, April 14.
„ between Ariadeus and Silberschlag, 1897, October 3.

In nearly every case the above sketches reveal additions to those mentioned in any of the existing maps. At present it would be inopportune to enter upon a discussion of these, a task which must be deferred till further observations accumulate, and the opportunity of giving the necessary illustrations presents itself. In the meantime the sketch of the Ariadeus system by Capt. Molesworth is reproduced in Plate II., and this will give a good idea of the excellence of the sketches which are catalogued above. In addition to the well-known features, a curious jointed appearance is seen in several parts.

Torricelli.

Capt. Molesworth sends a drawing of this curious formation as seen 1897, October 1, showing the dual crater filled with shadow, also a curious ray from the N.E. wall as if there was a tunnel-like opening in the rampart through which the sunlight penetrated to the surrounding "mare." The sketch also shows a portion of the wall of a ruined ring-plain to the W. of Torricelli which was originally as large as Theophilus.

Micrometic Measures of Ptolemaus.

PRELIMINARY REPORT.

§ 1. *Method of Observation.*

These measures were commenced in 1896 in response to Mr. Elger's appeal, and have been continued on most clear nights when Ptolemaus has been near the terminator, and the moon at sufficient altitude. Progress has been slow, partly on account of irregularities in my driving clock, which were not overcome until the close of 1897, partly on account of want of experience, and partly on account of the inherent difficulties. Many of the objects on the floor are so difficult that they are seen only intermittently on the best nights, and so minute as to be completely hidden by the micrometer web. Many lunations also have been lost through clouds.

A few distances have been measured, but the usual method has been to measure the position angle of the line joining A and *d* at least three times, and usually again later in the evening; the mean of these measures being entered as the value at the mean of the times. The position angles of the lines joining A and *d* to other formations have then been measured, and corrected for change of tilt of the moon's axis, so as to reduce them all to the mean time for the measures of A *d*. This change of tilt may amount to as much as 15′ per hour when the moon's R.A. is near 6 hours or 18 hours; when near 0 hours or 12 hours the change is very slight. Under high illumination *d* becomes a comparatively difficult object, whilst 11 is usually distinctly seen as a bright spot; under these conditions the line joining 11 and H has been taken as the initial line, the angle this line makes with A *d* being approximately known, the angle made by any measured line with A *d* is at once determined. Measures from 11 have then been substituted for those from *d*. This has also been done in several cases where the lines from A and *d* were too nearly parallel to give a good determination. They have also, in a few cases, been combined with measures from A and *d* for purposes of control. Measures from the cone of Herschel have sometimes been similarly employed. Measures made in this way are inferior to those of position angle and distance from the same point, in that the angle of intersection is often far from a right angle, but they are more expeditiously made, and are far easier when either the driving or the atmosphere is unsteady.

When distances have been measured they have been corrected only for change in the moon's diameter by introduction of the

factor $\frac{s}{s'}$, where $s = 15' 34''$, the moon's mean semidiameter, and s' is the apparent semidiameter at the time of observation, obtained from the "Nautical Almanac," and corrected for the moon's altitude. No correction has been applied for the conversion of conical into orthogonal projection; the principal effect of this would be to reduce the scale by about 0·4 per cent., a degree of accuracy to which I cannot hope to have attained; nor has any correction been made for differential refraction, the amount of which has never been sensible.

In consequence of the favourable position of Ptolemaus it was hoped that the corrections applied would give the positions with sufficient accuracy for the purpose of making a chart, as a complete reduction of each measure would have involved an amount of computation beyond anything I could have undertaken. It seemed desirable, however, to form some estimate of the possible errors introduced by the neglect of other corrections: an outline of the method adopted in this investigation, and the principal results, are given in the next Section of this Report.

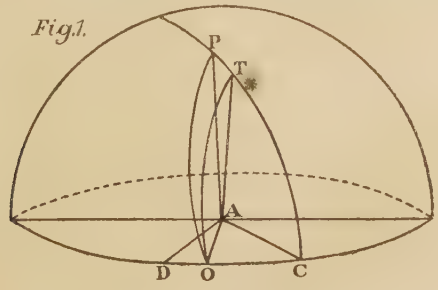
A more serious cause of error is to be found in the well-known difficulty experienced in bisecting a lunar formation of any size, and in the shifting of the apparent centre under varying illumination. To eliminate these errors observations should be taken under as many different angles of illumination as possible; most of my measures have been made under morning illumination.

My aim has been to measure each line at least three times on each of three nights, and I have usually endeavoured to observe the most difficult objects the definition permitted. If the measures have not been fairly accordant, more have been taken, but the group have not been allowed to count as more than three in the final means; if they have been badly discordant the whole have been rejected and easier objects tried. The measures are yet far from complete, and though I have divided the results so far obtained into two classes, yet of those observed on three nights, many have not been measured three times on each night. A series is often interrupted by failure of definition or the appearance of clouds.

§ 2. *Possible effects of Libration.*

In order to determine the possible errors introduced by neglecting the corrections due to libration it is necessary to connect the observed angles and distances with the true lunar bearings and arcs. This may be done as follows:—

Fig. 1.



Let A be the origin from which the measures are made,
P the formation whose azimuth and distance from A are required,
AT the tangent at A to the lunar great circle through A, P,
AO the line of sight,
AD the tangent to the lunar great circle through A, and the apparent centre of the moon's disk,
AC the production of the moon's radius through A, and therefore the common section of the planes PTA, ODA.

Let s' = the apparent semi-diameter of the moon,
s = " " mean " " " "
ρ' = the distance of A from the apparent centre of the disk expressed in selenographical arc,
α = the angle PAT,
θ = " DOP,
γ = " OCP.

The line joining the observer to the apparent centre of the disk is in the plane COA and makes an angle $s' \sin \rho'$ with AO

Hence arc $OC = \rho' + s' \sin \rho'$

Also arc $CT = \frac{\pi}{2}$

$\therefore$ from the spherical triangle CPO

$$\cot \theta \sin \gamma = \tan \alpha \sin (\rho' + s' \sin \rho') + \cos (\rho' + s' \sin \rho') \cos \gamma.$$

For Ptolemaus A, $s' \sin \rho'$ is always less than 5′ and will be neglected.

$$\therefore \cot \theta = \tan \alpha \sin \rho' \operatorname{cosec} \gamma + \cos \rho' \cot \gamma$$

From this it follows that, if α be so small that $\tan^2 \alpha$ may be neglected, variations in θ and γ are connected by the equation

$$\frac{\delta \theta}{\delta \gamma} = \frac{\cos \rho'}{1 - x^2} - \frac{x \tan \alpha \, (\cos 2 \rho' + x^2)}{(1 - x^2)^2}$$

where $x = \cos \gamma \sin \rho'$.

In measuring the difference in bearing from A of two formations we measure the difference between the two values of θ, the true difference being that between corresponding values of γ. The above equation therefore gives the ratio between the true and measured values of a small angle. If α may be neglected altogether, this lies between $\cos \rho'$ and $\sec \rho'$. The greatest possible value of ρ', taking geocentric librations, is 17°·8. The values found during my observations range between 4°·4 and 15°·0. Taking the last value, the ratio lies between ·966 and 1·04, showing that the measure of a small angle may be wrong by 4 per cent.

It is, however, of more importance to discover the possible accumulation of error for a larger angle, that is the greatest value of $\theta \sim \gamma$.

To find this we put $\delta (\theta - \gamma) = 0$, or $\delta \theta = \delta \gamma$, which gives

$$(1 - x^2)^2 = (1 - x^2) \cos \rho' - x \tan \alpha \, (\cos 2 \rho' + x^2).$$

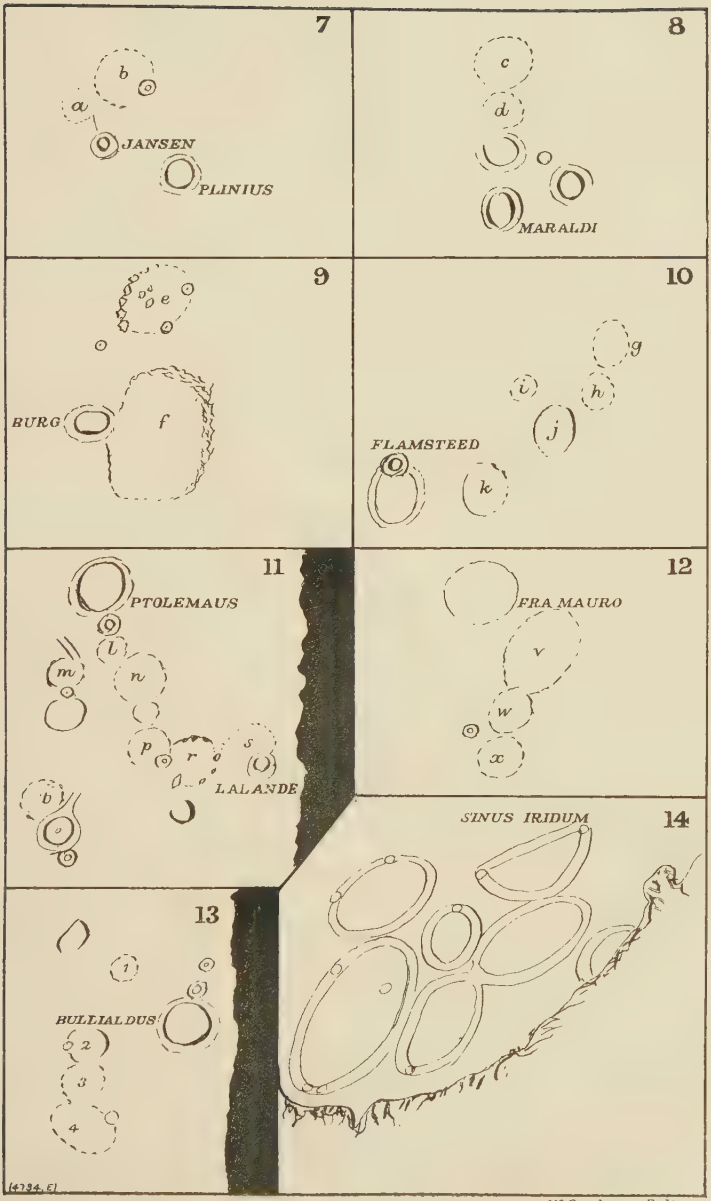
FIG. 1. ARISTARCHUS AND HERODOTUS.
(1898, March 5, 9 h. to 10 h.)
By W. Goodacre, F.R.A.S.

FIG. 2. MESSIER AND REGION.
(1898, October 1, 10 h. to 11 h. 25 min.)
By Ernest Attkins.

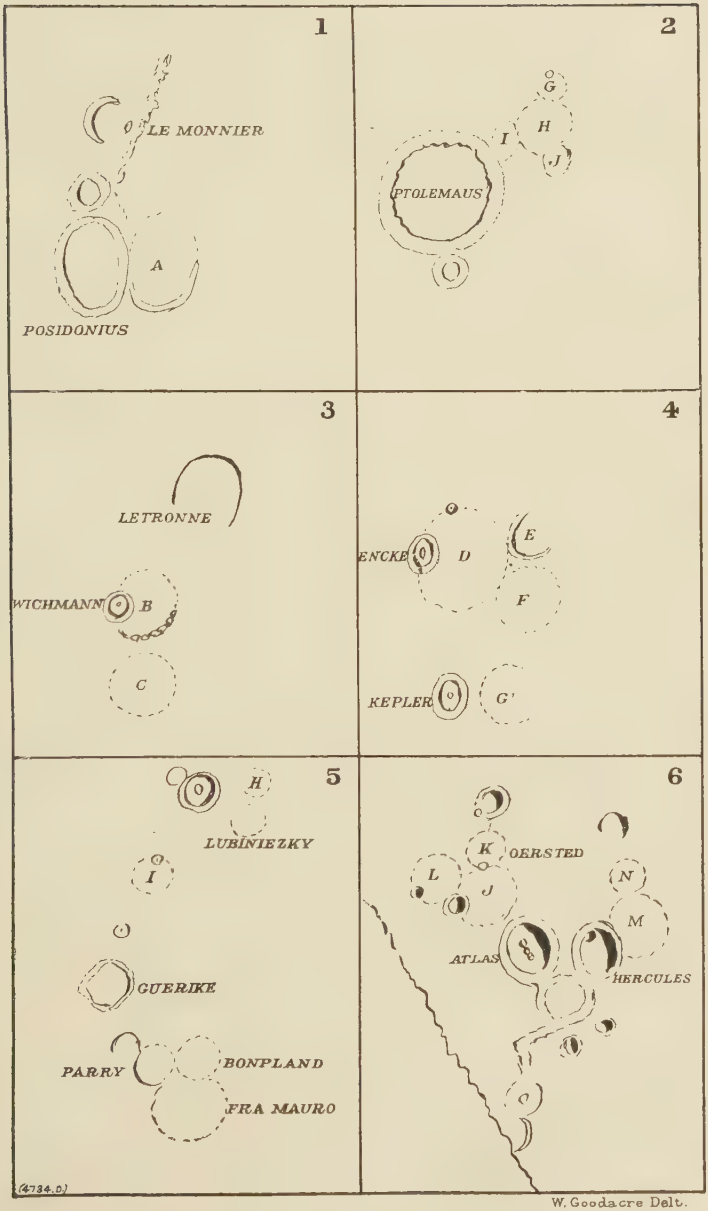
FIG. 3. ATLAS.
(1892, August 10)
By Capt. Molesworth, F.R.A.S.

FIG. 4. COPERNICUS.
(1898, March 2, 8 h. to 10 h.)
By C. F. Smith.

2
1
MARIUS 1896 Aug 21
by Capt.n Molesworth F.R.A.S.
LANDSBERG
REINHOLD
B
Craters
N.E REINHOLD 1898 Ap 30
by W. Goodacre F.R.A.S.
Ariadeus
Cayley
Whewell
Silbarschlag
ARIADEUS CLEFT 1897 Oct 13
by Capt.n Molesworth F.R.A.S.
POSIDONIUS 1894 May 10.
by Capt.n Molesworth F.R.A.S.
MACLEAR 1898 Sep 5
by W.J. Hall.



W. Goodacre Delt.


1
LE MONNIER
A
POSIDONIUS
2
G
H
I
J
PTOLEMAUS
3
LETRONNE
WICHMANN
B
C
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ENCKE
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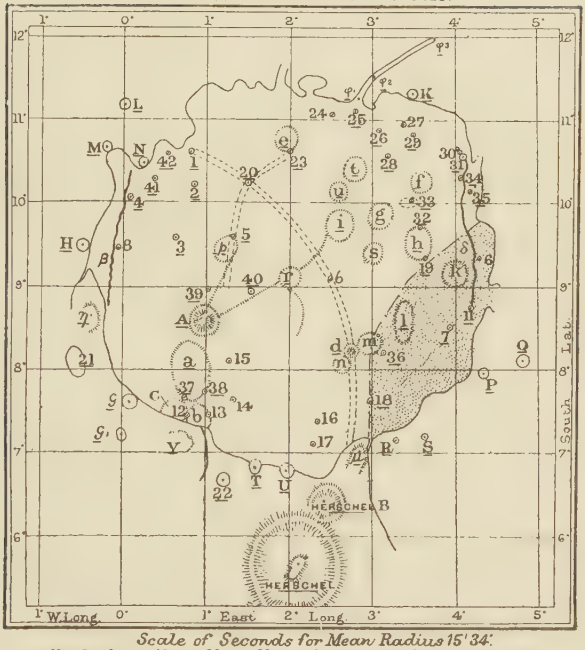
ATLAS
HERCULES
W. Goodacre Delt.

PTOLEMAUS.

DIAMETER OF MOON=50 INCHES.



Scale of Seconds for Mean Radius 15'34".

Approximate Scale of Miles.

(4734.H.) *The true scale varies by about 2½ per cent.*

This is a biquadratic, but if we examine the position of its roots we find that, since $\cos \rho' \neq 1$ and α is small, two of them are numerically greater than $\sin \rho'$, and therefore do not give real values of γ.

If $\alpha = 0$ the other two solutions are $x = \pm \sqrt{2} \sin \frac{\rho'}{2}$

When α is small the values of x will not differ much from these.

If we put $x = \pm \sqrt{2} \sin \frac{\rho'}{2} + \delta x$, and neglect terms of the second order in δx and α, we obtain finally,

$$\cos \gamma = \pm \frac{1}{\sqrt{2}} \sec \frac{\rho'}{2} + \frac{1}{2} \tan \alpha \, (2 \cos \rho' - 1) \operatorname{cosec} \rho'.$$

Few of the distances measured from A exceed 60 miles, which would give $\tan \alpha = \cdot 0277$.

If we now put $\rho' = 15°$, we find $\gamma = \pm 40°{\cdot}2$ or $\pm 131°{\cdot}6$
The corresponding values of θ are $\pm 40°{\cdot}9$ or $\pm 130°{\cdot}3$
The differences being $0°{\cdot}7$ and $1°{\cdot}3$.

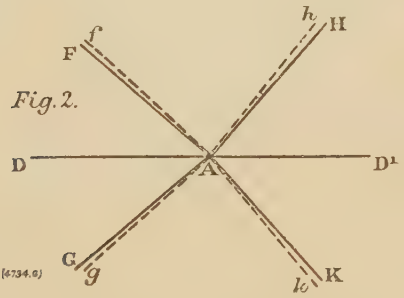


Fig. 2.

If A (Fig. 2) be the origin from which the measures are made, AD the direction of the apparent centre of the moon's disk which is measured in its true direction, then the line AF, which, on the lunar surface makes an angle $40°{\cdot}2$ with AD, will be projected and measured in the direction A*f*, so that the angle DA*f* appears $0°{\cdot}7$ larger than the true bearing DAF.

Similar remarks apply to the other lines in the figure, the angle DA*g* being also $0°{\cdot}7$ larger than the angle DAG, and the angles D'A*h*, D'A*k* each $1°{\cdot}3$ larger than the angles D'AH, D'AK.

The greatest error of excess will, therefore, be made in measuring the angle HAK which will appear $2°{\cdot}6$ too large, whilst the angles FAH, GAK will appear $2°{\cdot}0$ too small.

At mean libration when $\rho' = 8°{\cdot}6$, the corresponding values of γ are $\pm 36°{\cdot}9$ and $\pm 128°{\cdot}2$, those of θ being $\pm 37°{\cdot}0$ and $\pm 127°{\cdot}7$, the differences being respectively $0°{\cdot}1$ and $0°{\cdot}5$.

The way in which these angles depend upon ρ' may be seen from the following table, which gives in the third column the

greatest possible difference between the true and measured values of any angle; in the second column the angle for which this difference occurs; and in the first column the distance of the vertex from the apparent centre of the disk. The distances of the points H and K from A are throughout taken at 60 miles.

ρ'	HÂK.	hÂK—HÂK.
°	°	°
5	113·3	0·4
10	101·6	1·3
15	96·9	2·6
20	93·9	4·4
25	91·5	6·7
30	89·2	9·5
35	86·9	12·9
40	84·4	17·0

It must be remembered, however, that the angle which should be shown on a map is not usually the true lunar bearing, and hence the greatest "difference" here found is not the same thing as the greatest possible "error" of a measure, the term "error" being used to denote the difference between the angle as measured and as it should be drawn. Our object is to represent the appearance under mean libration. When ρ' is small the lunar azimuth of the apparent centre, that of the line AD (Fig. 2), may differ so much from that of the mean centre, that an angle which occupies the position HAK under mean libration, and should be represented in excess of its true value, may get nearly into the position KAG and so be seen too small, and *vice versâ*. As ρ' increases this possible change of azimuth decreases.

Thus in Ptolemaus, the angle HAK, in which the greatest "difference" occurs at mean libration, may, under other conditions be seen too small instead of too great. But the angle which occupies this position when ρ' has its greatest value, 17°·8, also appears too great at mean libration, though not to the same extent.

When, therefore, ρ' is small the possible "error" of a measure may exceed the "difference" given above; when ρ' is great, it can never be so large.

It must also be remembered that we are here considering the greatest possible error in a particular angle on the most unfavourable night. The errors in the means, caused by the neglect of the libration corrections, will be much less than these.

The variations in the apparent length of any line may also be determined from Fig. 1.

If D' be the distance of the moon's centre at the time of observation, Q' the measured length of AP.

The distance of A from the observer is—

$$D'\sqrt{1 - 2\sin s' \cos \rho' + \sin^2 s'},$$

and $$Q' = \frac{AP \sin OP}{D'\sqrt{1 - 2\sin s' \cos \rho' + \sin^2 s'}}.$$

If we denote the corresponding quantities at mean libration by omitting the accents, and ϕ be then the value of OP.

$$Q = Q' \frac{s}{s'} \sqrt{\frac{1 - 2 \sin s' \cos \rho' + \sin^2 s'}{1 - 2 \sin s \cos \rho + \sin^2 s}} \frac{\sin \phi}{\sin \mathrm{OP}}$$

The correction $\frac{s}{s'}$ has been applied.

The factor under the radical only affects the fourth place. We need, therefore, only consider the variations of $\frac{\sin \phi}{\sin \mathrm{OP}}$.

The numerator depends only on the position of the formation whose distance from A is being measured; for different formations it may vary between 1 and cos $(\rho + \alpha)$.

The denominator depends partly on the position of the formation and partly upon the libration, it may vary between 1 and cos $(\rho' + \alpha)$.

Hence, on different nights and for different formations, the factor may vary between cos $(\rho + \alpha)$ and sec $(\rho' + \alpha)$.

If we again assume the distance of the formation from A to be 60 miles, and $\rho' = 15°$, the factor may vary between ·984 and 1·043, *i.e.*, some lines may be measured 2 per cent. too large, others 4 per cent. too small. It must again be remembered that these are the extreme values on the most unfavourable occasion.

It may be noted that a line for which $\sin \phi = 1$, that is a line at right angles to the line of sight at mean libration, can never be measured too long, and will usually be measured too short. Any other lines, and all angles, may appear either greater or smaller than under mean libration.

§ 3. *Reduction of the Measures.*

The first step is to determine the azimuth. For this, advantage was taken of the fact that the positions of Ptolemaus A and the cone of Herschel have been determined as points of the first order by Neison and Lohrmann respectively.

The sides of the triangle A, Herschel, *d*, were measured as follows:—

A — *d* = 28″·90	from 12	measures on	5 nights.
d — Herschel = 42″·15	„ 8	„	2 „
Herschel — A = 49″·75	„ 8	„	2 „

The computed angles of this triangle are, at Herschel, 35° 27′; at A, 57° 46′; at *d*, 86° 47′.

The angles were also measured directly as follows:—

At A, 57° 10′ from 12 measures on 4 nights.
d, 87° 11′ „ 17 „ 5 „
whence the deduced angle at Herschel is 35° 39′.

In the present imperfect state of the measures it would seem needless to adopt any more elaborate process than that of taking the means of these two sets of values. These give for the adopted values at Herschel, 35° 33′; at A, 57° 28′; at *d*, 86° 59′.

The adoption of these necessitates some alteration in the lengths of the sides. To the nearest tenth of a second these may be 28″·9, 41″·9, 49″·6, or 29″·0, 42″·1, 49″·8. The principle of "least squares" gives decided preference to the latter set, which are accordingly adopted.

The positions given by Neison and Lohrmann show that the projection of the line joining A and Herschel should make an angle 21° 50′ with that of the principal meridian. This value is adopted. But these positions also show that the projected distance between the two points should be 51″·7, or 1″·9 greater than that found above. According to the usual method of determining points of the second order, this also should be adopted, and other distances altered to suit it. It is, however, so much greater than the value resulting from my direct measures, and this latter agrees within such much closer limits, not only with the lengths of the other sides of the triangle just considered, but also with the few other lengths that have been measured (as may be seen from the table of residuals given below), that for the present I retain my own value of the distance. The divergence will not, I think, seem excessive to those who are acquainted with the differences between the co-ordinates of the same points, when determined as points of the first order by different observers. It does not exceed Neison's estimate of the probable error in either co-ordinate of either point, and is, therefore, less than the probable error in the distance between the two. I have adopted the co-ordinates obtained from Neison's measures of Ptolemaus A in preference to those from Lohrmann's of the cone of Herschel, because the latter is such a large, irregular object, that I cannot feel certain that I have measured from the same point as that taken by Lohrmann. This same uncertainty affects both the adopted azimuth and the rejected length of the line joining the two points. I have endeavoured to measure from that point at which the shadow shows the highest peak to be situated, this is in the southern part of the area. Where it has been necessary to adopt co-ordinates for Herschel in the reductions, I have taken those resulting from my own measures as described above. I hope eventually to obtain positions of a few points by careful and fully reduced measures from Mösting A, which is very conveniently situated.

The position of 11 was next found, the measures of angle from A and *d*, and distance from A, being combined by least squares with weights proportional to the number of settings on which each depends, the length A*d* being taken as 29″·0. The residuals were not sensible.

Wherever other points have been determined by more than the necessary number of conditions, these have been combined by least squares, but without allowing variations of the relative positions of the four points A, *d*, 11, Herschel.

The degree of accuracy actually attained will be more profitably considered when the measures are further advanced. Some idea of what this is likely to be may perhaps be obtained from the following facts.

The most frequently measured angle was that between the lines A*d* and A1. This has been measured 24 (ranking as 21) times on eight nights, the values for the different nights being 105° 50′,

104° 50′, 105° 35′, 104° 55′, 105° 25′, 105° 18′, 106° 16′, 105° 32′, the mean being 105° 23′.

The most frequently measured distance was A*d*, measured 12 times on five nights, as follows :—29″·1, 28″·6, 29″·1, 29″·0, 28″·6, mean 28″·9, and value adopted, as explained above, 29″·0.

The following table shows the residuals in cases where solutions have been effected by least squares, this residual representing the perpendicular distance of the final position from the observed lines :—

Quantity Measured.	Position Angle from A.		Position Angle from *d*.		Position Angle from H.		Position Angle from Herschel.		Distance from A.	
Formation.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.	Residual.	No. of Measures.
	″		″		″		″		″	
11	0·0	11	0·0	5	—	—	—	—	0·0	3
1	−0·1	21	+0·4	7	−0·3	6	—	—	—	—
19	+0·2	6	−0·1	6	+0·2	6	—	—	−0·1	3
20	−0·1	8	+0·3	8	−0·8	3	—	—	—	—
21	−0·1	9	—	—	—	—	−0·6	3	+0·4	2
25	+0·1	8	−0·3	3	—	—	—	—	+0·3	1
32	−0·1	9	+0·2	7	+0·7	1	—	—	—	—
36	−0·1	2	+0·1	3	+0·4	3	—	—	—	—
39	0·0	12	−0·2	4	+0·3	3	—	—	—	—
H	−0·1	12	−0·5	4	+0·6	9	—	—	0·0	9

With the exception of those for H, all the residuals which exceed 0″·4, belong to measures made on a single night, and the impression left on my mind from a study of the whole is that while such measures are liable to sensible error, the means of those made on several nights are sufficiently accurate for practical purposes, amongst which I would include the production of a map on a large scale, the computation of the state of illumination at any given time, and use in future discussions as to possible changes in the lunar surface.

In the following Table, the values of X and Y are given, as usual, in parts of the moon's radius; the axis of X is—as in Neison—the projection of the moon's equator, the axis of Y that of the first meridian :—

Selenographical Positions of Formations.

	Longitude.	Latitude.	X.	Y.
	° ′ ″	° ′ ″		
Ptolemaus A, as determined by Neison.	−0 58 22	−8 34 58	−·01679	−·14924
Cone of Herschel, as determined by Lohrmann.	−2 9 7	−5 37 6	−·03737	−·09789
Cone of Herschel, position adopted	−2 7	−5 44	−·0366	−·0997

Formations measured on three or more nights.

Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
d	− 2 45	− 8 15	−·0473	−·1435
1	− 0 49	−10 38	−·0140	−·1844
4	− 0 5	−10 4	−·0015	−·1748
11	− 4 12	− 8 46	−·0724	−·1525
19	− 3 38	− 9 21	−·0625	−·1626
20	− 1 30	−10 14	−·0258	−·1777
22	− 1 12	− 6 42	−·0210	−·1169
25	− 2 47	−11 7	−·0476	−·1927
31	− 4 6	−10 36	−·0701	−·1838
32	− 3 34	− 9 45	−·0614	−·1692
39	− 1 2	− 8 59	−·0178	−·1561
G	− 0 5	− 7 38	−·0015	−·1329
G_1	0 0	− 7 16	+·0001	−·1264
H	+ 0 29	− 9 31	+·0082	−·1652
K	− 3 29	−11 18	−·0595	−·1961
M	+ 0 12	−10 41	+·0035	−·1854
N	− 0 14	−10 30	−·0040	−·1821
R	− 3 18	− 7 11	−·0570	−·1250
S	− 3 38	− 7 13	−·0628	−·1256
T	− 1 34	− 6 51	−·0273	−·1192
U	− 1 53	− 6 48	−·0340	−·1183
Herschel B	− 2 25	− 6 26	−·0418	−·1122

Formations measured on less than three nights.

Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
2	− 0 53	−10 14	−·0152	−·1775
3	− 0 39	− 9 36	−·0112	−·1666
5	− 1 20	− 9 36	−·0230	−·1668
7	− 3 57	− 8 31	−·0681	−·1481
18	− 2 59	− 7 38	−·0516	−·1330
21	+ 0 33	− 8 7	+·0095	−·1412
23	− 2 0	−10 38	−·0344	−·1845
26	− 3 5	−10 53	−·0528	−·1889
28	− 3 11	−10 35	−·0545	−·1838
29	− 3 29	−10 51	−·0597	−·1881
33	− 3 29	−10 2	−·0597	−·1742
34	− 4 3	−10 19	−·0696	−·1791
35	− 4 10	−10 9	−·0716	−·1763
36	− 3 9	− 8 15	−·0545	−·1435
37	− 0 46	− 7 41	−·0131	−·1338
38	− 1 1	− 7 46	−·0175	−·1350
40	− 1 33	− 8 58	−·0267	−·1559
41	− 0 26	−10 17	−·0073	−·1785
42	− 0 33	−10 35	−·0094	−·1837
L	0 0	−11 10	·0000	−·1937
P	− 4 20	− 7 57	−·0749	−·1383
	− 4 48	− 8 8	−·0828	−·1415
η	+ 0 20	− 8 38	+·0059	−·1502
μ	− 2 49	− 7 2	−·0488	−·1224
ν	− 0 42	− 7 11	−·0122	−·1252

Formation.	Longitude.	Latitude.	X.	Y.
	° ′	° ′		
a	− 0 49	− 8 1	−·0142	−·1395
e	− 1 58	−10 46	−·0337	−·1867
h	− 3 31	− 9 30	−·0606	−·1651
i	− 2 36	− 9 46	−·0446	−·1697
l	− 3 22	− 8 36	−·0582	−·1496
p	− 1 14	− 9 26	−·0212	−·1640
r	− 2 1	− 9 7	−·0348	−·1584
s	− 3 1	− 9 27	−·0519	−·1642
t	− 2 47	−10 26	−·0479	−·1812
u	− 2 35	−10 9	−·0443	−·1763

a, *e*, *h*, *i*, *l*, *p*, *r*, *s*, *t*, *u*, denote the approximate positions of the centres of these saucer-shaped depressions; they are, from their nature, subject to larger errors than the other objects in the list.

s is very shallow, smaller than *h*, and to the west of it.

Of the other formations in this list not shown in Mr. Elger's last map (Memoirs, Vol. iii., Pt. 5, Plate I), those on the walls, denoted by capital letters, are all conspicuous. K, L, R, S are circular craters of the same type as H; M, N, P, Q, T, U are larger and more nearly resemble 21, 22. Those on the floor are small. 32 is on the S.E. border of *h*, 33 is on the E. end of a conspicuous bright patch; 34, 35 are two small craters N. of 31; 36, another small crater, E. of *d*; 37, 38 are on the rim of *a*, and are clearly shown in one of the Lick photographs; 39, 40, 41, 42 I have seen only under fairly high illumination, when they appear as small well defined bright spots, their appearance being similar to that of other small craters on the floor under similar conditions.

Mr. Elger (Memoirs, Vol. III., Pt. 5, p. 157) describes 5 as "a conspicuous crater." I have never been able to see it as a crater, but there is a brighter patch on the bright streak running southwards from A in about the position indicated. It is the position of this bright patch that I have measured. On the next page Mr. Elger describes two craters at 31, 30. I am able to confirm Mr. Maw's observation (Memoirs, Vol. ii, Pt. 2, p. 31) that under suitable illumination three confluent craters may be seen here, of which 31 is the most northerly.

On plotting the positions given above it seemed probable that 23 is associated with *e* in the same way that 37, 38 are with *a*, or 19, 32 with *h*, but I have not obtained direct evidence of this. *v* is the high mountain mass on the N. wall, a little west of the line joining A—22.

S. A. SAUNDER.

P.S.—It will be evident from what has been said above, that if any approach to accuracy is desired it will not be possible to neglect the libration corrections when mapping formations much further from the mean centre of the disk than Ptolemaus. Since the report was written, however, Prof. H. H. Turner, F.R.S., has very kindly suggested a method of applying these corrections by which a considerable saving is effected in the computation required, with no loss of accuracy. I have already taken some measures

for formations nearer the limb, and hope I may be allowed to return to the point when I have acquired more familiarity with the work. S. A. S.

The map has been constructed as follows:—The measured points were first laid down on squared paper on the scale of 200 inches to the moon's diameter. The contour of the foot of the walls was drawn at the telescope between 8^h and 10^h on 1898, November 22, and the positions of five or six points on it determined with the micrometer. These points were laid down on the squared paper and the contour drawn in after comparison with two photographs--Paris Observatory Atlas, Plate III., under morning illumination, and Lick Observatory Atlas, Plate IV., under evening illumination—which were kindly lent me by Prof. Turner. I hope that in this way substantial accuracy has been secured. The other formations were drawn in chiefly from Mr. Elger's map in the Third Report of the Lunar Section, "Memoirs," Vol. III., Part 5, supplemented by a few notes of my own. Traces were found of *b*, *c*, and the two low ridges from A to *p* and *r* on the Lick photograph, as also of the light spot about 33 and of the dark patch in the N.E. corner. The contour of this last was drawn on November 22, and extends further than that shown by Mr. Elger. The two bright streaks intersecting at 20 were drawn at the same time.

The drawing having been completed on the squared paper, a tracing was made, which has been reduced by photography to one-fourth the original size. In the preparation of this tracing I have received very great assistance from Mr. H. W. Owen Hagreen, to whom I am much indebted.

In order to facilitate use at the telescope the designations of those objects whose positions have been measured have been underlined. It is very desirable that the positions of other objects should be determined by cross alignments from these.

S. A. S.

The Director would like to emphasise the closing remark by Mr. Saunder as given above, the positions of so many objects have now been determined that with the aid of the chart identification should be a comparatively easy matter, and by the method of alignment new objects can be inserted with close approximation to accuracy—more objects could have been inserted in the map, but it has been thought well not to risk overcrowding it. Four have, however, been inserted on the authority of Herr Krieger's map; a rill β under the W. wall and a small crater on its eastern side No. 8, also a corresponding rill on E. side δ, and a small crater, No. 6, between it and E. wall; this latter has been seen by the Director, and also the rill δ in part, 1893, March 25. Much valuable help has been given by the Rev. A. Mackay, M.A., in confirming many of the craters in the chart, and in locating others whose exact positions have yet to be determined.*

W. G.

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* Two errors occur in the lettering of the map. *For* "C" *read* "*c*"; and *for* "V" *read* "*v*."

SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—REV. W. R. WAUGH, F.R.A.S.

SEVENTH REPORT OF THE SECTION.

REPORT FOR THE APPARITION OF 1897 AND 1898.

PART 1.

INTRODUCTORY.

As heretofore, this Memoir will be divided into five Parts. Part 1, is a general introduction; Part 2 a general account of the disk observations, with a more detailed account of the drawings selected for reproduction; Part 3 is a selection of various papers on Jovian features of interest and value; Part 4 consists of satellite observations; and Part 5, a condensed summary of the work with a few deductions therefrom.

The weather in the earlier portion of the apparition was very unfavourable for observing faint planetary details, hence the period covered by the observations has not been so long as on some previous occasions, though there is no reason to believe that there has been any slackening of interest.

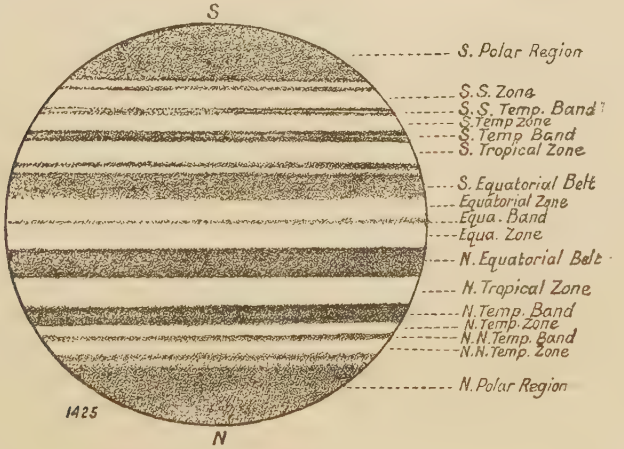
The following is a list of the Members of the Section up to date, with the usual particulars.

Name.	Locality.	No. of Drawings.	Instrument.
WM. ANDERSON, F.R.A.S.	Madeira	8	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	—	—
E. ATTKINS	Highgate	—	—
E. G. AYLETT	Bredgar	—	—
Rev. J. BAIKIE, F.R.A.S.	Ancrum	—	—
G. BANASTER, F.R.A.S.	Tewkesbury	11	4-in. O.G.
W. M. BAXTER	Edinburgh	—	—

Name.	Locality.	No. of Drawings.	Instrument.
LEO BRENNER	Lussinpiccolo	—	—
J. H. BRIDGER, Mus.B.	Farnborough	20	4-in. O.G.
G. L. BROWN	Stirling	—	—
R. W. BUTTEMER	Godalming	—	—
B. E. CAMMELL, F.R.A.S.	Wokingham	—	—
H. Y. CHILDS	Portland	6	4·5-in. O.G.
J. E. CLARK, B.A., B.Sc.	York	—	—
E. J. COPE	Malvern	1	$8\frac{1}{2}$-in. spec.
H. CORDER	Bridgwater	—	—
A. COTTAM, F.R.A.S.	Watford	1	$12\frac{1}{2}$-in. spec.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—	—
R. CROSS	Oxford	—	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	—	—
HY. ELLIS, F.R.A.S.	Potter's Bar	—	—
E. ESSAM, F.R.A.S.	Billingboro'	6	12-in. spec.
J. EVERSHED, F.R.A.S.	Kenley	—	—
R. FALCON	Workington	—	—
Rev. T. H. FOULKES, M.A.	Malta	5 parts	$10\frac{1}{2}$-in. spec.
A. FREEMAN	Hastings	—	—
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	—	—
W. GOODACRE, F.R.A.S.	Crouch End	—	—
H. F. GRIFFITHS	Streatham	2	6-in. spec.
ED. HALL	Bjorneburg	—	—
W. J. HALL	Nantwich	10	$4\frac{7}{8}$-in. spec.
G. P. B. HALLOWES, F.R.A.S.	York	—	—
A. HENDERSON	Liverpool	—	—
E. R. HICKS	Kensington	—	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—	—
W. H. IZZARD	Brentford	—	—
J. JACKSON	Blackpool	—	—
W. E. JACKSON, F.R.A.S.	Liverpool	—	—
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	Sats.	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	—	—
Rev. R. KILLIP, F.R.A.S.	St. Annes-on-Sea	11	5-in. O.G.
N. LATTEY	Cardiff	—	—
J. LUNT, B.Sc.	Ealing	—	—
HY. MACEWEN, F.R.A.S.	Glasgow	—	—
W. H. MAW, F.R.A.S.	Kensington	—	—
J. W. MEARES, F.R.A.S.	Calcutta	14	$9\frac{1}{4}$-in. spec.
A. MEE, F.R.A.S.	Cardiff	5	$8\frac{1}{2}$-in. spec.
F. K. MELLOR, F.R.A.S.	Huddersfield	—	—
P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	52	$12\frac{1}{2}$-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	3	$12\frac{1}{4}$-in. spec.
J. ORR	Glasgow	—	—
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—	—
Dr. G. PATTERSON, M.A.	Ascot	—	—
Rev. T. E. R. PHILLIPS, M.A.	Yeovil	9	9-in. spec.
J. PHILLIPS	Hereford	2	12-in. spec.
W. T. PRICE	Wellington	—	—
Rev. V. REID	Glasgow	—	—
C. ROBERTS, F.R.A.S.	Kensington	—	—
Dr. RYLE, M.A.	Brighton	—	—

Name.	Locality.	No. of Drawings.	Instruments.
W. C. STEWART	Clapton	—	—
Dr. SMART, F.R.A.S.	Bermondsey	1	10½-in. spec.
C. F. SMITH	Edinburgh	17	5¼-in. spec.
H. F. SMITH	Luton	16	6¼-in. spec.
Rev. W. SWINDLEHURST	Wickham, N.S.W.	9	—
C. A. TAYLOR	London	—	—
H. J. TOWNSHEND	Leeds	6	9½-in. spec.
J. M. WADMORE	Exmouth	12	3·1-in. O.G.
Rev. W. R. WAUGH, F.R.A.S.	Portland	11	4·5-in. O.G.
Rev. L. A. WILLIAMS	New Shoreham	—	—
A. STANLEY WILLIAMS, F.R.A.S.	Brighton	—	—
H. WRIGHT	Sydney, N.S.W.	2	8·5-in. spec.
J. WYKES	Birmingham	5	4·5-in. O.G.

We insert the adopted nomenclature diagram, its general acceptability justifying its continuance. It may be well to caution new members against its use for indicating latitude, though this is hardly necessary, as changes in latitude are abnormal this apparation, especially in the case of the two Equatorial belts, and the N. temperate band.



We have great pleasure in recognising the value of Mr. Crommelin's Jupiter tables as published in the Monthly Notices of the Royal Astronomical Society. He has well supplied the place of the much-regretted Herr Marth for all Jovian students.

Also the section is much indebted to Dr. Smart, who has supplied similar tables in MS. for the use of his co-workers, and also other figures for computation purposes. Dr. Smart's tables came to hand several weeks before the publication of Mr. Crommelin's, and refer to Marth's systems I. and II. for computing the longitudes of the central meridians of the disk drawings; the coincidence of the two sets of tables from separate sources indicates

general accuracy. With pleasure we mention here two papers by Mr. J. H. Bridger, Mus.B., to facilitate the latitude and longitude finding of Jovian spots and markings, such as those recorded in the very interesting papers in Part 3. It is an indication of progress that qualified members of the section are issuing papers of this careful and useful character. Mr. H. Y. Childs has also assisted in some computations.

The total number of drawings sent to the director this apparition from observers in England has been 170, from observers in other lands 76, making a total of 246. Those not reproduced will be found in the Jupiter Album for 1897 and 1898.

As this seventh memoir is the last under the present Director, it may be well to call attention to the fact that while each memoir is complete in itself as a condensed record of the work accomplished by the co-operation of the several Members who have been assiduous during the apparition, to obtain a full view of the work of the Section it is necessary that the seven memoirs should be studied in their entirety; moreover, as references are constantly made to previous memoirs, we recommend that recent Members of the Section should possess themselves of the whole seven, and recur to them as occasion requires. Such references would soon give a good introduction, if not a complete mastery of Jovian literature. A thoughtful study of the disk reproductions alone would amply repay the small expenditure, as well as aiding the not over-supplied treasury. Moreover, increased funds would ensure more numerous reproductions in the future. The advantage of binding the memoirs separately, as well as collectively, is not to be overlooked where frequent reference is desired, and it only involves one extra copy. Perhaps the time of a change in the direction may be thought by some a suitable one for such separate binding. The retiring Director would call special attention to Jovian papers which have appeared in the Journal. They are by no means of an ephemeral character, and would have formed a portion of this or previous memoirs did they not seem to require a more immediate publication.

With great pleasure we call attention to the masterly "Beobachtungen der Jupiter" of Prof. Phil Fauth with 84 excellent reproductions of disk drawings and 5 well-arranged charts of the planet. They cover the apparition of 1896 and 1897, and form a valuable memoir of high-class work, and should be studied by all members of the section who are desirous of making progress in Jovian work.

PART 2.

Though in this Memoir the several workers have been permitted to speak for themselves of what they have achieved in Jupiter observing, the returns have been so copious and minute, that it was, as heretofore, found impossible to print *in extenso* a tithe of the material which has come to hand, hence the following description of the planet during the apparition is a condensed and collective *resumé* of the main features of drawings and reports, the latter being often of a fragmentary character.

1. The equatorial zone has been decidedly darker than normal, especially in its northern portion, which often seemed a diffusion from the N. equatorial belt. In the earlier period of the apparition it was of a decidedly yellow colour, often with a reddish tone, both which tints gradually faded towards the close of the observing period. It was occasionally flecked with numerous ill-defined light masses, which, when definition was poor, gave it a mottled appearance. The faint equatorial belt was rarely seen, probably owing to the above over-lying material, and when glimpsed it was generally broken and diffuse. Wisps have been frequently seen on good nights. They were seen in all longitudes, and as a rule more diffuse than usual. They almost invariably seemed to spring from dark spots or protuberances on the N. edge of the S. equatorial belt. They rarely extended as far as the N. equatorial belt. The trend of these curious features was generally eastward, some being slightly curved as if affected by rotational drift. The average angle at which they stood in relation to the equator might be given at 45°, some few being, however, nearly parallel with the meridian line. During the previous apparition the influence of rotational drift on the wisps was not so apparent, as many of the positions stood at an angle opposed to it. Messrs. Phillips, Charles and Harold Smith, Meares, and Banaster, and Capt. Molesworth have been among the most successful in observing these weird objects.

2. The S. equatorial belt has been, on the whole, the most active of the Jovian features. The dividing line of light matter, giving the belt a duplex aspect, has been very apparent, all the good drawings to hand showing it, in many cases from limb to limb, except in the region of the bay, where it is arrested by the two shoulders. The following shoulder has been well marked, presenting the appearance of dark condensed material heaped up by the bay. The preceding shoulder has been far less conspicuous, but sufficiently so to form a clearly defined bay, in which the faint remains of the Great Red Spot still lie, and which has been very occasionally seen. It is the current opinion that it is more visible than last apparition. The very few among the 246 drawings of the sections which show it do not support this view. When shown it has a pale ghostly aspect, always so light in its central portion as to give it the appearance of a ringed nebula. Its present aspect gives little hope of its ever resuming the tint of its name. Messrs. Essam, Banaster, and Molesworth show it plainly. The trumpet-shaped rifts, chiefly on the N. edge, have not been much in evidence this appariton, only few observers showing them. There have been, however, a large number of dark and light spots of varied intensity, shape, and size, many of them projecting far into the equatorial zone.

3. The N. equatorial belt has, on the whole, been far less active than during the last apparition, though the abnormal disturbance has by no means ceased, as the diffused extension of its S. edge plainly shows, an extension which gave rise to the supposition that there was an additional belt. The main body of the belt has been very much attenuated. Both edges have had many light and dark spots. The S. edge had occasional extensions,

giving that portion of the belt a wavy appearance. In drawings taken in February and March by Messrs. Killip, Charles Smith, and Offord this curious but evanescent feature is shown.

4. The S. temperate band has not been very conspicuous this apparition. Drawings by careful observers show it as little more than a straight line. On several, by the Rev. T. E. R. Phillips it is shown duplex, and occasionally there are wavy widenings of this belt. It has probably not attracted sufficient general attention, owing to its inconspicuousness.

5. The N. temperate band has been very attentuated and featureless during the whole apparition. Its latitude has gradually increased. Very recent measures seem to show that it is receding to its normal position, *see* 4th part. It does not appear at all on many drawings.

6. The two tropical zones have been fairly bright, but there has not been the average number of light well-defined spots on the S. tropical zone this apparition. The remarkable dark spots on the N. tropical zone have been closely observed by several. For particulars as to their rates of drift, *see* 3rd part, where tables of their periods are given.

7. The N.N. and S.S. temperate bands have been rarely seen. Messrs. Killip, Phillips, and Molesworth have been successful in detecting these difficult objects. The diffuse ringed aspect of the polar regions is an indication of their presence, and when seeing conditions are good they often yield to prolonged gazing.

8. On both polar regions there have been dark indistinct markings, seen as they ever must be, at a greatly foreshortened disadvantage, it is hardly likely they will awaken much interest. It is nevertheless true, that these regions are well worth more attention than they generally receive, and are likely to pay for special observation. The little that is known ought to be a stimulus to further application. Recent papers on their colouring by Mr. Bridger, and others, are a step in the right direction. A few diffuse markings have been seen on these regions. *See* Capt. Moleworth's work in the 5th part. The entire date-range of the drawings is from December 1897 to May 1898.

The general descriptions, as heretofore, will be arranged in six sections, embracing 60° of longitude each. Recent Members of the Section would do well to refer to the "Memoirs" for 1891 and 1892 for explanations of this arrangement.

The following is the usual condensed description of the drawings in each section.

Section I., longitude 0° *to* 60°.—There are 34 drawings in this Section. Nearly all are available for comparison. Traces of the Great Red Spot, chiefly of the following end, are shown in 7 drawings. In two cases the entire faint oval form is shown. The bay in which it lies is shown plainly in every drawing. The following shoulder is seen prominently in all, but the preceding shoulder is only well shown in 14 drawings. The S. equatorial belt is shown very prominently in all the drawings and duplex in the preceding portion in 14. In the following portion only in 12.

Equatorial wisps are shown in 7 drawings, Messrs. C. and Harold Smith and Phillips being the most successful in detecting them. Light and dark spots and mottling are well shown in nearly all the drawings. The orange tint is well shown in 10. The drawings of Messrs. Phillips and Anderson show it prominently at the date of its greatest intensity.

The N. equatorial belt is shown faint and attenuated in all. The shading on its S. edge is shown on nearly all, and the faint S. component by Messrs. Molesworth, Killip, C. and H. Smith, Phillips, Banaster, Waugh, and others; its visibility being largely dependent on date.

The S. temperate band is shown by all, and the thickenings in various longitudes chiefly over the bay. The polar regions scarcely call for further remark here as they are fully discussed elsewhere. Messrs. Molesworth, Phillips, Killip, Childs, C. and H. Smith show traces of the fainter belts, especially those in the northern region. *See* Part 5.

Messrs. Phillips, Molesworth, Banaster, C. Smith, H. Smith, Waugh, Childs, Anderson, Killip, Bridger, Essam, Meares, Wright, and Hall contribute to this Section.

Section II., longitudes from 60° *to* 120°.—There are 24 drawings in this Section. They admit of comparison in about two equal portions as divided in longitude. One by Mr. Phillips shows a trace of the Great Red Spot near the limb, nine show the following shoulder, nearly all show the duplicity of the S. equatorial belt and its intensity, five show the orange colouring of the equatorial zone according to colour appreciation: Messrs. Offord, Phillips, Killip, Wykes, and C. Smith most clearly. Wisps are shown by Messrs. Offord, Phillips, and C. Smith. Light spots or markings are shown on this zone in 10 drawings, and dark spots on the N. edge of the S. equatorial belt on nearly all. Messrs. Meares, Banaster, Phillips, and Childs show them prominently. The N. equatorial belt is thin, but shows signs of more activity in some drawings in these longitudes, notably by Messrs. Offord, Molesworth, C. Smith, Killip, Phillips, Banaster, and Anderson. The S. component of the N. equatorial belt is shown on seven drawings, giving the aspect of duplicity to the belt in some cases, and in others that of an additional belt.

The S. temperate band is shown on 22 drawings. Mr. Offord shows it in some activity. The dark streak A is well shown on seven drawings. *See* Captain Molesworth's and Rev. T. E. R. Phillips' tables of its peculiar motion, &c. The N. temperate band is very attenuated, quite omitted in five drawings, only partially shown in a few; Messrs. Childs and Banaster show it slightly duplex. The polar bands are all shown very faint, except in the notable case of Capt. Molesworth's reproduced drawing, where the duplex and slanting N.N. temperate band is shown, with its three dark spots in $\lambda \pm 107°$ (*see* drawing). Dr. Smart shows this band duplex but parallel with the equator. The polar regions are normal, the N. being generally more dense. Messrs. Molesworth, Smart, Phillips, Bridger, Bannaster, Offord, Mee, Childs, Cottam, Offord, Wykes, Killip, Anderson, Hall, Wadmore, C. Smith contribute to this Section.

Section III., longitudes 121° *to* 180°.—There are 20 drawings in this Section; 14 are comparable. The orange tint of the equatorial zone is shown in fully half, but varies in intensity, according to the time of observation; wisps are shown in six drawings, and some white markings in several. The S. equatorial belt is shown duplex in five drawings, and dark and light spots on the N. edge, most of which project into the equatorial zone in nearly all. Mr. Meares shows a white bay on the N. edge of the N. component of this belt; Messrs. Banaster, Bridger, Phillips, Mee, show the faint S. component of N. equatorial belt; and H. and C. Smith and Banaster show the S. shading partly covering the equatorial zone very clearly. The S. temperate band is shown in a disturbed condition in all the drawings by Mr. Phillips. In the N. tropical zone the streak A is shown in six drawings. Messrs. Phillips, C. Smith, and Banaster indicate the faint line attached to it, a feature referred to in Capt. Molesworth's returns. The N.N. temperate band is shown in four drawings, in some cases strongly.

The N. and S. polar regions are normal, very much as in the previous sections.

Messrs. C. Smith, Bridger, Essam, Meares, Hall, T. Phillips, Killip, Banaster, H. Smith, Anderson, J. Phillips, and Mee contribute drawings to this Section.

Section IV., longitudes 181° *to* 240°.—Over one half of the 27 drawings in this Section are fairly comparable. The ruddy tint of the equatorial zone is shown in all the drawings, notably those by Messrs. Killip, Phillips, and Meares. Messrs. H. Smith, Phillips, Killip, Childs, Molesworth, and Meares are successful in seeing the wisps. The faint equatorial belt is shown partially by Capt. Molesworth. This is unusual in this apparition. Light masses are shown by nearly all in this zone. The S. equatorial belt is shown duplex in nearly all. Mr. Anderson shows it wavy in outline. A light rift is shown in Mr. H. Smith's drawing in $\lambda \pm 180°$. Dark or light spots are shown on the N. edge of this belt in nearly all the drawings. In Mr. Meares' two drawings they are large and of striking aspect, inclining to the N. The N. equatorial belt is shown duplex in six drawings. This arises from the S. component being indicated more clearly in some than others. Several of the drawings of later date show increased activity in this belt, in these longitudes, notably Messrs. H. and C. Smith, Childs, and Meares. The S. temperate band is shown in all. In Mr. Phillips' drawing some activity is seen in its following portion (date, December 20). In Capt. Molesworth's the same activity is shown. He also shows a bay on its S. edge, with an oval spot lying in it, a miniature of the Red Spot. The S.S. temperate band is shown in the same drawing, also a faint streak in the N. tropical zone. Faint lines are indicated in several drawings in the N. polar regions, also more slightly in the S. polar regions.

Messrs. Bridger, H. Smith, Phillips, C. Smith, Essam, Killip, Childs, Anderson, Waugh, Meares, Molesworth, Hall, contribute to this Section.

Section V., longitudes 241° *to* 300°.—There are 30 drawings in this Section, two thirds of which are comparable as to date. Ten show the orange tint of the equatorial zone, notably Messrs. Townshend, T. Phillips, Wykes, Killip, and Meares. Messrs. Banaster, J. Phillips, and Meares show wisps. The duplicity of the S. equatorial belt is shown in nearly all. Several spots are shown on the N. edge of this belt in 12 drawings. Messrs. Phillips, C. Smith, and Banaster show remarkable light spots on this belt. Mr. Griffiths shows a rift in λ 260° ±. The N. equatorial belt is shown in all the sketches—in some diffused—by Messrs. Banaster and Townshend as somewhat active. Mr. Meares shows a remarkable white spot on it, deflecting it northward in λ 240° ±. The dark streak in the N. tropical zone is shown by Messrs. Phillips, C. Smith, Banaster, Bridger, Meares, and Killip. *See* tables in Part 3. The S. temperate band is shown in all the drawings. Mr. Meares shows it thickened in the following portion. Mr. Phillips shows it duplex. Date, March 21.

The N. temperate band is attenuated in all the drawings where it is shown. Mr. Phillips shows the N.N. temperate band with markings on it. The polar regions are normal, Mr. Bridger and Mr. Mee showing the N. as of a steel blue; others show a bluish tint in both regions, but more marked in the N.

Messrs. Meares, Banaster, H. Smith, Waugh, Killip, Bridger, Griffiths, C. Smith, Phillips, Townshend, Offord, Essam, Wykes, Hall, and Mee contribute to this Section.

Section VI., longitudes 301° *to* 360°.—There are 39 drawings in this Section, seven of these showing the orange tint in the equatorial zone. Fourteen of the drawings show wisps, some diffuse, others as a well-defined line, all these wisps have their origin in spots or markings on the N. edge of the S. equatorial belt, and nearly all reach the N. equatorial belt. Mr. C. Smith shows a wisp-like marking as if drifting with the equatorial current. λ 340° to 350°. Date, March 31.

There are similar markings in a drawing by Mr. Offord. Date, 21st June. The S. equatorial belt is shown duplex in 30 drawings, with dark and light spots on the N. edge, or on the body of the belt. A drawing by Mr. Cope shows the belt in great activity and of abnormal form. The bay is well shown, in all the drawings, longitude permitting; in some cases on the limb; but the Great Red Spot is not shown on any except, perhaps, one by Mr. C. Smith, near the following limb, and by Mr. Phillips plainly. The preceding shoulder is generally at a lower angle than the following, as per date. Mr. Wykes shows the S. equatorial belt much disturbed, also do Mr. Mee and Mr. Harold Smith. A remarkable rift is shown in Mr. Hall's drawing; it debouches into the equatorial zone. Date, April 22. There is a remarkable light spot on the N. edge of this belt in Capt. Molesworth's drawing. Date, May 29. The N. equatorial belt is shown duplex in several drawings, but always very attenuated, though there are occasional thickenings. Mr. Cope's drawing shows some activity in this belt. The dark streak on the N. tropical zone is shown well on 16 drawings. *See* tables in Part 3.

The S. temperate band is shown on all the drawings, but without marked characteristics. The portion S. of the great bay

evidently slightly overlies the position of the Great Red Spot. The polar regions are normal, Messrs. Bridger, Meares, C. Smith, and Wykes showing them bluish in tint, especially the N. *See* Mr. Bridger's paper in the "Journal."

Messrs. Wykes, Childs, Offord, Cope, Bridger, C. Smith, Molesworth, Hall, Meares, Banaster, Wadmore, Anderson, J. Phillips, H. Smith, Killip, Wright, Waugh contribute to this Section.

Mr. Wadmore sends six black and white drawings of Jupiter not included in the above discussions and not intended for the Album. Mr. Swindlehurst's pencil sketches, though possessing some interesting features, are also not susceptible of the above treatment.

Capt. Molesworth's drawings that are to be returned are also only partially included.

The Great Red Spot.

In view of the much debated question of the visibility of the Great Red Spot during the apparition of 1897 and 1898, the following condensed paper by Capt. Molesworth will be interesting. The paper is corroborated as to its facts by other competent observers :—

"The Red Spot is very faint, and with poor seeing is invisible. Good definition, however, shows the outline still distinct, and I have even seen a faint salmon tinge still on one or two occasions. As a rule, however, it appears colourless. The central portion is rather fainter than the rest, and on March 26, I saw a small circular white spot just following the centre.

"The Bay in which the spot lies is very distinct, both shoulders being clear cut. The following shoulder is very dark, with a slight projection to the S., very near the point of the shoulder. The preceding shoulder is a mere outline, the N. component of the belt being dark and knotted, while the S. component is straight and line like. Considerable changes took place in the neighbourhood of the shoulders during the observations.

"The Red Spot, even in its present washed-out state, appears to exercise an enormous influence on the envelope of Jupiter. Traces of this influence are visible for a considerable distance on either side in longitude; and in latitude from the S. temperate band to the N. tropical zone, and are too striking to be the mere result of coincidences.

The chief phenomena which appear due in some way to the influence of the Red Spot are the following :—

(1.) The repulsion of the S. equatorial belt causing the formation of the bay in which the spot lies.

(2.) Increased activity in the S. equatorial belt preceding the Red Spot, and decreased activity following it. This is borne out by the number of transits of spots (taken during the observations in the different zones of longitude), in the N. edge of the S. equatorial zone. This increase in activity appears to be progressive, as the figures are—

Long.	0°	to 90°	27 spots.
"	90°	" 180°	38 "
"	180°	" 270°	51 "
"	270°	" 360°	66 "

(3.) The thickening of the S. equatorial belt in the same longitude as the spot, and its slight repulsion to the S.

(4.) The formation of various rapidly moving white spots in the S. temperate zone. These appear to form in the longitude of the Red Spot, and drift away in a preceding direction.

(5.) The absorption of the yellow tint, which is generally present in other longitudes, along the southern edge of the N. tropical zone.

The visibility of the Great Red Spot when near the limb is a very puzzling, but unquestionable phenomenon. It is much more distinct near the preceding than the following limb, but is visible right up to either limb. This may possibly be due to its being partially or wholly on a higher level than the rest of the surface.

The Director and other observers of the Section can endorse those views, except that marked No. 5, which may be attributable to other causes underlying the equatorial zone. The production of white spots, especially on the S. tropical zone, may arise from its heated condition as possibly indicated by its colour, a matter for still closer and prolonged observations in good air.

Capt. Molesworth's Micrometrical Measures of Jupiter.

Average Number of Settings, 6.—(*Abstract.*)

Date.	Trincomali, L.M.T.	Lat. of S. Eq. Belt.		Lat. of N. Eq. Belt, N. Edge.	Lat. of Centre of S. Trop. B.	Diameter of Planet.	
		N. Edge.	S. Edge.			Polar.	Equatorial.
1898.	h	° ′	° ′	° ′	° ′	″	″
Mar. 24	± 12	—	−13 44	+14 57	—	42·73	46·45
„ 25	9.45—12	—	—	—	—	43·00	46·12
„ 25	10.15—12	−2 41	14 20	14 13	—	39·13	—
„ 26	10.45—11.30	—	13 54	14 0	—	39·425	—
„ 28	10.30—11.30	—	13 52	13 14	—	42·48	44·10
„ 29	11—11.30	—	—	—	—	41·74	44·97
„ 31	10.80—11.30	3 42	—	—	—	41·735	43·962
May 5	6.15—6.45	—	12 12	12 30	—	37·455	—
„ 5	6.45—7.45	—	12 22	12 37	−23 39	38·243	—
„ 6	6.45—7.45	4 51	12 22	12 40	—	38·695	—
„ 10	5.45—6.30	—	15 21	15 31	24 18	38·192	—
„ 11	5.30—6.30	—	13 20	12 50	27 11	38·267	—
„ 12	5.20—6.15	—	13 15	14 45	—	38·311	—
„ 13	5.40—6.30	—	12 00	12 00	—	38·237	—
„ 14	5.30—6.30	—	16 01	14 25	—	38·282	40·551
„ 16	10.30—12.15	6 29	14 47	15 20	26 18	38·604	40·798
„ 17	5.30	—	—	—	—	—	—
„ 29	5.30—6.30	5 10	15 07	12 54	27 02	36·015	38·661
June 3	5.45—7.45	2 23	10 37	11 00	—	36·949	—
„ 5	6.0—6.30	—	15 26	13 06	—	37·090	—

In the above measures, the most noteworthy matter is the gradual shifting northward of the N. edge of the S. equatorial belt. Indeed, there seemed to be a general instability in the whole belt. Sometimes its material appeared partially transfused over more than half of the equatorial zone. Possibly the strong yellowish tint of that zone was largely occasioned by such transfusion. This and the fact that several of the measures were taken in daylight, must have made micrometer work on the planet difficult, and possibly vitiate some of the figures. These results, however, show the patience, skill, and persistence of Capt. Molesworth, in attacking and conquering the difficulties incident to such work. In the full tables, weights and limiting longitudes are given. Conciseness required these and some other details to be omitted. The powers used on the micrometer varied from 150 to 305, showing that the state of the air was a large factor in the results.

Description of the Plates.

Fig. 1, *Plate I.*, *Long.* 3° (*H. Wright*). Date, May 25, 1898. —The following shoulder and bay were very definite.

Fig. 2, *Plate I.*, *Long.* 7° (*Waugh*). Date, April 15, 1898.— The equatorial zone was a light orange with a mottled aspect. The S. equatorial belt was duplex and of a copper colour. The following shoulder and bay were very definite. On the margin of the bay there were three dark markings. There were several dark and light spots on the N. edge of this belt, which presented an appearance of considerable activity. The N. equatorial belt was far less prominent, and diversified with dark and light markings. The S. temperate band was wavy, and broken in parts. The N. temperate band was indistinctly seen. Both polar regions were banded in aspect, and of a greyish tint.

Fig. 3, *Plate I.*, *Long.* 19° (*Harold Smith*). Date, April 8, 1898.—The equatorial zone shows traces of the faint equatorial belt, a pronounced wisp and several light markings.

The S. equatorial belt is duplex. The shoulder is very distinct and dark. There is a well-defined trumpet-shaped opening in the preceding portion of this belt. The N. edge of the belt has several dark and light markings. The bay is well seen, and there are traces of the new light spot in it. The N. equatorial belt is duplex with dark markings, connecting the two portions of the belt. Both tropical zones are light and slightly mottled. Both temperate bands are shown, and the S.S. temperate band is also seen, indicating good seeing. The N. polar region is the darker one, and of a steel grey. A drawing full of interesting detail.

Fig. 4, *Plate I.*, *Long.* 33° (*Molesworth*). Date, May 3, 1898.—The equatorial zone is shown as of a deep yellow tint with four wisps, one of which extends right across the zone. The thin band in the northern portion is plainly shown. This feature is only seen under the best conditions. The S. equatorial belt is duplex, with six dark and three light spots on its N. edge.

There is also a white spot near the apex of the shoulder. The bay is distinctly formed. The Great Red Spot is seen as an oval grey marking, having lost nearly all its colour. The N. equatorial belt is diffused in its S. edge. The S. temperate band has two prominent markings on it, and the S.S. temperate band is plainly seen. The N. temperate band is very faintly shown, with a dark marking on its *f.* portion. The N.N. temperate band is also shown with a similar marking. The dark spot on the N. tropical zone is faint, and seems to indicate that it is variable. The N. and S. polar regions are normal.

Fig. 5, *Plate I., Long.* 36° (*C. F. Smith.*) Date, February 16, 1898.—The equatorial zone is of a reddish yellow. The S. equatorial belt is seen duplex in its preceding and following portion. The bay being on the meridian is shown in its fullest extent. The following shoulder is dark and prominent, presenting a striking aspect. There are three striking projections on the N. edge of this belt. The N. equatorial belt is disturbed with projections on its N. edge. It is olive coloured with a gap on the C. M. portion. The S. temperate band is well seen, and of a broken aspect. The N. temperate band is very faintly shown. The N. polar region is steel grey, and the S. ruddy.

Fig. 6, *Plate I., Long.* 63° (*H. Y. Childs*). Date, April 23, 1898.—The equatorial zone is mottled by diffuse light markings. The S. equatorial belt is copper coloured and duplex. The following shoulder is dark and prominent. There are four dark spots, and one white one on the N. edge of the belt. The one N. of the shoulder being diffuse. The N. equatorial belt is duplex and attenuated. The N. temperate band is definite, and the N. temperate band is seen duplex. This feature of the band is verified by several observers, and is supposed to be objective. The N. and S. tropical zones are covered with many light spots. There are also light spots on the two temperate zones.

Fig. 7, *Plate II., Long.* 67° (*Arthur Mee*). Date, June 17, 1898.—The equatorial zone shows the yellowish tinge. The S. equatorial belt is duplex, the division being irregular. The shoulder is prominent. The N. edge of the belt shows dark curved projections, a not uncommon aspect. There are also a few white markings on the edge. The N. equatorial belt is dense with white markings on the N. edge. The S. temperate band is very definite. On the N. tropical zone there is the well-known dark spot, detached from the belt. The other zones are mottled. Both polar regions are bluish.

Fig. 8, *Plate II., Long.* 72° (*Dr. Smart*). Date, April 23, 1898.—On the S. equatorial belt, which is shown duplex, there are three dark spots. On the N. equatorial belt there are five dark spots. On the S. temperate band there are three dark spots. On the S. tropical zone there are three light spots. The N. tropical zone is also very light, with an indefinite marking on the following limb. The N. temperate band is distinct, and the N.N. temperate band is shown duplex, an unusual feature this apparition. Both polar regions are dark.

Fig. 9, *Plate II.*, *Long.* 84° (*Cottam*). Date, April 16, 1898. —The equatorial zone is dark. The S. equatorial belt is well-defined, and of a chocolate colour. The N. equatorial belt is of the same tint, but much narrower. The N. temperate band is very slight. The S. temperate band is well-defined. The S. tropical zone is bright. The N. tropical zone is much duller. Both polar regions are dark.

Fig. 10, *Plate II.*, *Long.* 94° (*Wykes*). Date, June 5, 1898. —The equatorial zone is of a decided yellow colour. The S. equatorial belt is duplex and chocolate colour. The N. member of this belt has several diffuse spots on it, and has a curious marking trending southward very near the preceding limb. The N. equatorial belt is dark and much thinner, and has similar markings to the S. belt. The S. temperate band is unusually thin, the N. temperate band being the better defined. The polar regions are dark.

Fig. 11, *Plate II.*, *Long.* 107° (*Molesworth*). Date, May 18, 1898.—The equatorial zone of the usual yellow tint. There are several misty wisps preceding from the N. edge of the S. equatorial belt. The thin band in the N. portion of the zone is shown. The S. equatorial belt is irregular in both edges, showing considerable disturbance. There are several light spots on its surface, probably the division broken up. The N. equatorial belt is of a purple tint with four dark spots on its N. edge. The S. temperate band is irregular. The S.S. temperate band has two dark spots on its following portion. The N. temperate band is fairly well seen as compared with its usual aspect this apparition. The N.N. temperate band is duplex and angular with the equator, with three dark round spots near the meridian. The polar regions are dark purple.

Fig. 12, *Plate II.*, *Long.* 143° (*Killip*). Date, June 10, 1898. —The equatorial zone is orange-coloured. There are two wisps projecting at an angle from dark spots on the N. edge of the S. equatorial belt, on which belt there are three white spots giving an arched appearance to the belt. The N. equatorial belt is olive tinted. The S. temperate band is of the same tint, a light spot is seen on its preceding portion. There is an elongated dark spot on the N. tropical zone. Both polar regions are dark. There is a trace of the N. temperate band.

Fig. 13, *Plate III.*, *Long.* 151° (*Banaster*). Date, March 6, 1898.—The S. equatorial belt is seen very distinctly with three dark spots on its N. edge with associated white spots, imparting a bridged appearance. The N. equatorial belt is much narrower. Both belts are shown duplex. The S. temperate band is attenuated. There is a remarkable spot of a diffused aspect on the N. tropical zone, with a thin band projecting from its following end to the planet's limb; being at an angle to the equator it is noteworthy. The N. polar region is of a greyish tone.

Fig. 14, *Plate III.*, *Long.* 205 (*Meares*). Date, December 3, 1897.—On the equatorial zone there is a remarkable oval dark spot, apparently an extension of the N. member of the S. equatorial belt. From the spot and the belt there are two wisps.

There is also a large white spot preceding the following wisp. The S. portion of the S. equatorial belt is attenuated. The N. equatorial belt is duplex, the N. member having a projecting spot to which the preceding wisp is attached. The S. tropical zone is bright. The S. temperate band is pronounced, with a small light spot on it. The N. temperate band is shown. The two polar regions are dark. Altogether a most remarkable drawing.

Fig. 15, *Plate III.*, *Long.* 243° (*Townshend*). Date, April 21, 1898.—The faint equatorial belt is just visible with a slight widening in about long. 200°. The S. equatorial belt is seen duplex, the southern member of which is irregular on its S. edge. On the northern division there are seen dark prominences, extending into the equatorial zone, which zone is seen of yellowish tint. The N. equatorial belt is much narrower, and has a wavy dark line extending over two-thirds of its length, there are also two white spots on this belt. Both temperate bands are faintly shown without any specific features.

Fig. 16, *Plate III.*, *Long.* 322° (*Offord*). Date, June 21, 1898.—The equatorial zone has a lengthened dark marking—very diffuse—probably not the faint equatorial belt. There is also a light marking on the following portion. The S. equatorial belt is divided, the N. portion being of a chocolate tint and the S. portion red. The belt is broken by a gap. The N. equatorial belt is also of a reddish brown colour, and mottled. The S. temperate band is very distinct, of a greyish slate colour. The N. temperate band is slightly shown. Both tropical zones are white and both polar regions are banded, the S. being slate coloured and the N. polar region being darker. Colouring is very distinctly seen by this observer.

Fig. 17, *Plate III.*, *Long.* 343° (*Cope*). Date, January 2, 1898.—The S. equatorial belt is shown as much contorted, with a slight belt in its S. portion. The N. equatorial belt is less abnormally formed, with extensions N. and S., that on the N. edge being very pronounced. The S. temperate band is broader than usual, and of a reddish brown tint. Both equatorial belts are of a very dark brown colour. Polar regions normal.

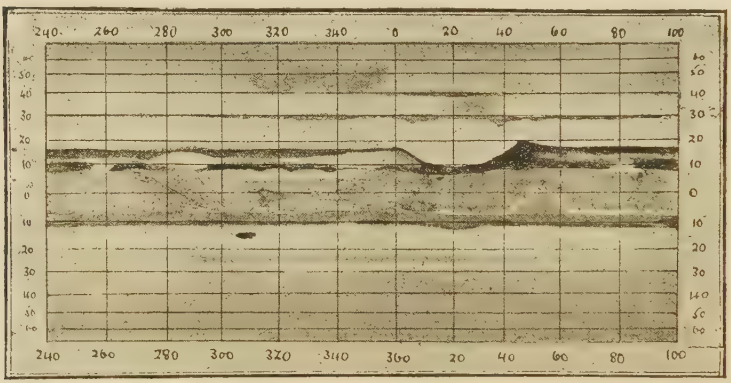
Fig. 18, *Plate III.*, *Long.* 355° (*Phillips*). Date, March 29, 1898.—These are traces of the faint equatorial belt and two wisps, with a wedge-form dark marking, possibly a more diffused wisp. The S. equatorial belt is duplex, the S. member being thin where it forms the preceding portion of the bay. The bay itself is well defined, the shoulder being very dark. The Great Red Spot is faintly seen. The inner portion of it being lighter giving the usual ringed appearance. There are two light spots on the N. edge of the belt. The N. equatorial belt is diffuse in its southern portion, and extends somewhat into the equatorial zone, giving the darkening aspect frequently seen at this date. The two tropical zones are very bright. The S. temperate band is duplex. On the N. zone there is a dark spot preceding. The N. temperate band is faintly shown. Also the S.S. temperate band. A most interesting drawing.

CHARTS.

It is a sign of progress that a larger number of these compact presentations of the markings of Jupiter has been returned. The Director asks attention to a special paper in the "Memoir" for 1896–97 on this important, and not very difficult mode of recording disk observations, implying as it does preparation and carefulness in observing. The charts are as follows:—

One of the whole surface, by Mr. J. H. Bridger, showing the more prominent markings. It is constructed from ten drawings made between April 15 and April 23 inclusive. As the interval is brief its value is enhanced. The relative positions of the two well-observed streaks on the N. tropical zone give their longitudes as approximately 120° and 300° for the above dates. A 4-in. O.G. was used. The chart is preserved in the Album.

One is returned by Capt. Molesworth, R.E. It is characterised by his usual care and skill. The amount of detail is very great; it is for the whole surface, and is in close agreement with those



by Messrs. Bridger and Smith. Nearly all the markings shown on his 52 drawings are reproduced on the chart, chiefly in the southern portions of the disk. It is matter of great regret that this exquisite chart cannot be reproduced in the "Memoirs," as it is to be returned to Ceylon. Capt. Molesworth has also returned a chart of Satellite III., which, of course, exceeds the results ordinarily obtainable. It is referred to in Part 3.

Capt. Molesworth has adopted the semi-transparent key, reference duly numbered, as in the charts of Herr Brenner, which makes them so convenient for comparison with the drawings.

One by Mr. C. F. Smith, which is reproduced here. It is constructed from drawings made from the end of March and the beginning of April. The inclusive longitudes are 100° to 240°. It shows considerable detail, especially in the equatorial zone and the S. equatorial belt. It is in fair agreement with that of Mr. Bridger.

The chief features of Mr. Smith's chart are thus described by him:—

> *Equatorial zone*, yellow-orange in colour, with five diffused dark markings, one longitudinal one starting from a projection from the N. equatorial belt in λ0.

S. equatorial belt duplicate and active, with dark N. edge and dark and light spots thereon. Large oval white spot, about λ290. *p* and *f* "shoulders" high, the former appearing like an outline, owing to the great widening of the rift, *f* shoulder pointed towards the S. N. p. corner of bay very dark.

N. equatorial belt narrow, with dark N. edge. Latitude less than at last opposition, the equatorial zone being therefore narrower. Belt gray in colour.

S. temperate band not very dense, with usual thickenings over Red Spot.

N. temperate band very faint, and only partially seen.

N. tropical zone very white on S. side. Dark spot in λ310 surrounded by white aureola.

S.S. temperate band dark over Red Spot region.

S. polar region reddish, with two contiguous dark markings.

PART 3.

Transits of Spots, &c.

Capt. Molesworth's dark and white spots transits are very full and complete, but are far too copious for their reproduction. He also gives the transit of prominent features of the belts, and other markings, with powers used, definition, and interesting remarks where needed, occupying about 50 pages of foolscap MS., all of which refer to his 52 disk drawings, with a number of special sketches on the margin of his notes, all of which are elaborately drawn. He also gives four pages of diagrams illustrating the shiftings in longitude of carefully observed spots. The above remarks are due to Capt. Molesworth for his industry, skill, and perseverance in observing.

Dark Markings in N. Tropical Zone.

Denning's Letter.	Character of Spot.	Longitude at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h m s
A	A dark wisp, Prec. end	122	Mar. 24	July 1	20	9 55 27·8
	A dark wisp, Foll. end	131	Apr. 5	„ 1	17	
a	A shorter streak *p.* A, similar, but very faint.	80	May 3	„ 10	5	35·2
B	A short dark wisp, Prec. edge	266	Apr. 1	May 14	4	23·2
	A short dark wisp, Centre	267	Mar. 25	„ 31	3	
	A short dark wisp, Foll. end	268	Apr. 6	„ 14	3	
C	Diffuse streak, Prec. end	304	Mar. 25	June 20	20	24·4
	Diffuse streak, Foll. end	309	Apr. 7	July 2	17	

White Spots in S. Temperate Zone.

Letter for Spot.	Character of Spot.	Longitude at δ.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
						h m s
ζ	White spot	47°	May 11	June 30	4	9 55 5·8
η	White spot	73	„ 11	„ 30	6	6·4
θ	White spot	97	June 1	July 10	4	9·0

The centre of the bay surrounding the Great Red Spot proved a difficult object to observe.

	Centre of bay	22	Mar. 26	July 10	16	9 55 41·9

The following rotation periods are deduced from transits observed by Mr. T. H. Bridger, who used an excellent 4-in. O.G. Though they are eye-estimates they have been taken with great care, the transit of the centre of the spot being taken in each case. The observations are corrected for the light equation, but not for the defect of phase.

Dark Spots in N. Tropical Zone.

A	Dark spot	124	Apr. 23	June 5	4	9 55 29·4
B	Dark spot	313	„ 17	„ 11	5	22·5

In computing the longitudes for both the above tables, system II. has been used throughout.

Rotation Periods of Spots determined by the Rev. T. E. R. Phillips during the Opposition of 1898.

The longitudes of the spots included under the great equatorial current are based on System I. of Mr. Crommelin's Ephemeris for Jupiter, whilst longitudes of extra-equatorial spots are based on System II. During the opposition of 1898 the great equatorial current included the N. component of the S. equatorial belt, the equatorial zone, and the N. equatorial belt. The mean rotation comes out as $9^h\ 50^m\ 24^s{\cdot}2$ as computed by Mr. Phillips. Mr. Phillips concludes also from his observations that several of these spots exhibit great irregularities of motion; a conclusion corroborated by other trustworthy observers. The adopted periods of these equatorial spots varied between $9^h\ 50^m\ 15^s{\cdot}1$ and $9^h\ 50^m\ 33^s{\cdot}6$.

Spots on N. Edge of S. Equatorial Belt.

No. of Spot.	Character of Spot.	Long. at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h. m. s.
I.	White -	28	Apr. 18	June 30	6	9 50 25·1
II.	Dark -	31	Mar. 28	July 5	4	28·0
III.	White -	60	Apr. 25	„ 5	7	28·6
IV.	Dark -	75	„ 25	June 19	5	19·7
V.	White -	88	„ 12	July 5	15	20·8
VI.	Dark -	100	Mar. 29	„ 5	12	21·9
VII.	White -	109	„ 22	June 1	6	22·2
VIII.	Dark -	119	„ 22	„ 17	8	27·3
IX.	White -	127	„ 22	„ 10	5	30·5
X.	Dark -	137	Apr. 23	„ 22	3	28·9
XI.	White -	146	Mar. 20	„ 22	13	27·9
XII.	Dark -	154	„ 13	July 15	14	28·5
XIII.	White -	276	„ 23	June 11	6	17·4
XIV.	Dark -	283	„ 14	„ 9	8	21·3
XV.	White -	310	„ 21	„ 16	6	17·9
XVI.	Dark -	323	„ 21	July 2	10	15·1
XVII.	White -	347	„ 21	June 30	11	23·3
XVIII.	Dark -	355	„ 21	„ 16	11	27·0
XIX.	„ -	353	June 5	„ 30	5	33·6

The motions of Spots V. and VI. were irregular. Spot VII. appeared on June 10 to have become united with another spot seen on June 1 in longitude 111°·1. Its observed positions after June 1 have, therefore, been omitted in deducing the rotation period. The observations of Spots XVI., XVII., and XVIII., made on May 15, indicate a very remarkable and sudden change in longitude. These vagaries of motion are, however, well corroborated by other observers. Spot XVII. was observed also on June 5 and 7, but it appeared double on these dates, and the positions have not been used in deducing the period.

Several other spots were observed in the above region, but satisfactory periods could not be determined.

The mean rate for spots on the N. edge of the S. equatorial belt was $9^h\ 50^m\ 24^s\cdot2$; but the period differed for different longitudes, as the following table will show :—

Approximate Longitude at ☌ ; 1898, March 25.	No. of Spots.	Mean Rotation Period.
		h. m. s.
From 75° to 109° - -	4	9 50 21·2
„ 119 „ 154 -	5	28·7
„ 276 „ 323 - -	4	17·9
„ 347 „ 60 -	6	27·6

Spots on N. Equatorial Belt.

No. of Spot.	Character of Spot.	Long. at ☌.	Dates of Observation. First.	Dates of Observation. Last.	No. of Obs.	Mean Rotation Period.
		°				h. m. s.
XX.	White, with reft.	129	Apr. 5	May 21	5	9 50 27·6
XXI.	Dark -	143	May 14	June 22	5	26·0
XXII.	„ -	323	„ 31	„ 16	3	19·9

The rate of motion of the N. equatorial belt seems to have approximated very closely to that of the N. edge of the S. equatorial belt. Thus, Spots I. and II. on the N. equatorial belt fall within the limits of that region of the S. equatorial belt which exhibited a period of $9^h\ 50^m\ 28{\cdot}7^s$.

Extra-equatorial Spots.

No. of Spot.	Character of Spot.		Long. at ☌.	Dates of Observations. First.	Dates of Observations. Last.	No. of Obs.	Mean Rotation Period.
			°				h. m. s.
XXIII.	The Red Spot - -		23	Mar. 29	June 19	8	9 55 42·4
XXIV.	Dark Spots in Lat. ± 40°.	Dark ellipse -	177	„ 23	May 12	6	6·2
XXV.		Dark condensation of S.S. Temperate Band.	343	May 4	June 16	9	7·8
XXVI.	Dark Spots on N. Tropical Zone. Lat. + 15°.	A.	128	Mar. 13	July 4	14	27·7
XXVII.		B.	264	„ 28	June 30	9	25·8
XXVIII.		C.	310	„ 21	July 10	17	24·5
XXIX.	Dark Streaks on N.N. Temperate Band. Lat. + 33°.	I.	40	Apr. 25	May 31	5	53·4
XXX.		II.	269	Mar. 21	June 4	8	49·8

The transits of the dark streak, No. XXIX., were taken of the preceding end. The motion of Spot No. XXVIII. was not uniform.

Mr. Phillips also gives a full and particular account of the aspect of the Jovian disks with many marginal pencil sketches which are shown in his drawings in the Album and utilised in Part 2.

Speaking of the great equatorial current, Mr. Phillips writes: "The rate of motion of this current showed a very striking "increase as compared with that of previous years. In 1897 the "rotation period of the southernmost part of this current was "determined by Mr. A. Stanley Williams as $9^h\ 50^m\ 34^s{\cdot}6$."

The mean derived from his own observations as given in the foregoing tables is $9^h\ 50^m\ 24^s{\cdot}2$ or $10^s{\cdot}4$ less.

SPOT TRANSIT TABLES, by WALTER J. HALL.

The following are my eye-estimates of transits over the Jovian central meridian of 14 different positions on the N. and S.E. belts, with the rotation periods derived from them.

The first is believed to be pretty accurate, but the rest I have not felt justified in carrying beyond the nearest *second*. There is a wider difference between the highest and lowest rate of the nine spots on the N. edge of the S.E.B. than could be desired, no doubt a larger and better mounted instrument would diminish this, though I believe it is in part due to proper motion in the spots themselves. It is to be regretted also that some have only been observed to transit twice.

The mean times, however, given in the summary are thought to be a very fair approximation to the truth.

Ten selected drawings accompany this report to illustrate its points.

September 1898. WALTER J. HALL.

1898.

SUMMARY OF ROTATION PERIODS OF SPOTS.

Spot No.		h.	m.	s.	No. of Rotations.	
1	The Great Shoulder	9	55	43·3	128	
2	On the N. side of S. equatorial belt.	9	50	31	100	Mean of 9 spots $9^h\ 50^m\ 33^s{\cdot}2$.
3				33	66	
4				29	44	
5				24	88	
6				53	17	
7				45	17	
8				32	56	
9				12	17	
10				40	61	
11	On the S. side of N.E.B.	9	50	19	22	Mean $9^h\ 50^m\ 22^s{\cdot}5$.
12				26	61	
13	On the N. side of N.E.B.	9	55	20	63	Mean $9^h\ 55^m\ 21^s{\cdot}5$.
14				23	122	

1898.

LIST OF DARK EQUATORIAL WISPS, by WALTER J. HALL.

No.	Approximate Position of S. extremity. (System I.)	Issuing from Spot on S.E.B.	To Spot on N.E.B.	Dates Observed.
α	9°	No. 2	—	February 22, April 4 (part way across on latter date).
β	33	„ 3	—	March 8, April 4.
γ	47	„ 4	—	April 16, May 4 (short on latter date).
δ	75	„ 5	No. 11 (λ 82°)	April 16, 18, 25, May 4.
ε	153	„ 7	—	April 12, May 12.
ζ	188	—	—	May 3.
η	227	No. 8	—	April 1.
θ	253	—	—	April 1.
ι	282	No. 9	—	February 24, March 14, 21.
κ	322	„ 10	No. 12 (λ 327°)	February 24, March 3, 14.

PART 4.

SATELLITE OBSERVATIONS.

Though the number of satellite observations is not so large as in 1897, it is believed that they have improved in accuracy. Owing to the illness of Mr. Gale, who was our largest contributor on the last apparition, the returns from New South Wales will not be forwarded until the end of 1899. Captain Molesworth's returns will supply this deficiency. A short abstract of the markings Captain Molesworth observed on Ganymede and Callisto will be found at the end of this Part. He solicits corroboration when atmospheric conditions permit.

The Rev. S. J. Johnson, M.A., sends as follows. He also adds that "at the end of a period of eclipses of Satellite IV. some short "unpredicted ones may occur. Such might have been the case about "the 9th or 20th of April 1898, but cloud precluded observation on "those dates." It will be easy to calculate corresponding dates. Mr. Johnson also adds the following interesting note: "In an old "number of the 'Intellectual Observer' for October 1864, "page 225, on a supposed fifth satellite of Jupiter, there is a "paragraph as follows:—'M. Camille Flammarion,' writing in "'Cosmos' observes, 'that M. de Gasparis of Naples saw on the "'22nd of July at 7^h 59^m p.m. a black well-defined spot on the "'planet's disk; in a quarter of a hour this black point, moving

" ' in the direction of the planet's rotation disappeared, passing
" ' from the margin. M. de Gasparis asks if this is the same body
" ' that has been seen by Messrs. Long and Baxendall. M. Flam-
" ' marion says it could not have been a planet (asteroid ?) in
" ' conjunction with Jupiter, for in that case its motion would
" ' have been in the opposite direction, and it was not one of the
" ' four well-known satellites, as they were all visible.' Could it, he
" asks, have been a fifth small satellite ? "

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phe-nomena.	Phase.	Observed G.M.T.	Pre-dicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Feb. 8	I. Tr. E.	External contact.	10 58 15	10 58 —	H.	Seen under poor conditions.
Feb. 23	II. Tr. E.	Bisected	11 0 0	—	H.	
—	—	External contact.	11 2 45	11 3 —	H.	Definition fair.
—	I. Oc. R.	First seen	11 44 0	—	H.	
—	—	External contact.	11 46 0	11 46 —	H.	Definition good.
—	I. Oc. R.	First seen	11 45 30	—	K.	
—	—	Clear	11 47 0	11 46 —	K.	
Mar. 3	I. Tr. E.	Internal contact.	10 35 0	—	H.	
—	—	Bisected	10 41 0	—	H.	
—	—	Clear	10 43 30	10 42 —	H.	
Mar. 10	I. Sh.	On Central Meridian.	11 0 0	—	K.	Shadow well defined. Sudden sea fog.
—	I. Tr. I.	External contact.	10 11 0	10 13 —	H.	Definition fair.
Mar. 20	III. Oc. R.	First seen	8 55 0	8 56 —	H.	
Mar. 26	IV. Sh. I.	Just after external contact.	4 5 —	4 15 —	M.	Distinct penumbra.
—	IV. Sh.	On Central Meridian.	4 21 —	—	M.	Noted after C.M. passage.
—	IV. Sh. E.	—	5 4 —	4 59 —	M.	
—	IV. Conjn.	—	4 13 —	—	M.	Just clear of N. limb.
Mar. 27	I. Oc. D.	One diam. from limb.	5 10 —	—	M.	
—	—	External contact.	5 15 —	—	M.	Poor definition.
—	—	Gone	5 19 —	5 19 —	M.	
Mar. 28	I. Sh.	On Central Meridian.	3 43 —	—	M.	Shadow noted as smaller than satellite.
—	I. Sh. E.	Half off	4 46 30	—	M.	
—	—	Off disk	4 48 30	4 52 —	M.	
—	I. Tr. E.	Internal contact.	4 40 0	—	M.	No ellipticity noted before egress.
—	—	External contact.	4 44 30	4 48 —	M.	
Apr. 4	I. Tr. E.	Bright on disk.	6 8 —	—	M.	P. edge brighter than f.
—	—	Do.	6 15 —	—	M.	Distinctly elliptical.
—	—	Internal contact.	6 25 0	—	M.	Perfectly circular.
—	—	External contact.	6 29 25	6 32 —	M.	Do. do.
—	I. Sh.	On Central Meridian.	5 27 0	—	M.	Faint irregular penumbra.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Apr. 5	I. Ec. R.	Invisible	3 54 0	—	M.	
—	—	Bright	3 59 0	3 55 45	M.	First glimpse not seen.
Apr. 7	III. Tr. I.	External contact.	2 25 30	—	M.	
—	—	Internal contact.	2 42 0	2 33 —	M.	
—	—	Invisible	3 0 ±	—	M.	P. edge vanished $2^h\ 53^m$.
—	—	Grey streak	3 16 0	—	M.	
—	III.	On Central Meridian.	3 42 30	—	M.	Grey spot, darker nucleus.
—	—	—	4 23 0	—	M.	Part brighter than disk.
—	III. Tr. E.	Internal contact.	4 50 30	—	M.	
—	—	External contact.	5 4 0	5 6 —	M.	
—	III. Sh. I.	First contact.	3 36 30	—	M.	
—	—	Internal contact.	3 44 30	3 40 —	M.	
—	III. Sh.	On Central Meridian.	4 59 30	—	M.	Shadow larger than satellite.
Apr. 12	I. Ec. R.	First glimpsed.	5 47 30	—	M.	
—	—	Nearly bright.	5 49 0	—	M.	Elongated N. and S.
—	—	Fully bright.	5 50 35	5 49 40	M.	Disk normal.
—	II. Oc. D.	External contact.	5 45 40	—	M.	Appeared as a bright point while just inside.
—	—	Gone	5 49 10	5 50 —	M.	
—	II. Ec. R.	First seen	9 10 59	9 10 51	B.	Air steady.
—	—	Bright	9 13 32	—	B.	
—	II. Ec. R.	First seen	9 11 —	9 10 51	H.	
—	II. Ec. R.	First seen	9 11 30	9 10 51	J.	
—	—	Bright	9 14 0	—	J.	
—	II. Ec. R.	First seen	9 10 30	9 10 51	K.	
—	—	Bright	9 12 0	—	K.	
Apr. 17	I. Oc. D.	First contact.	10 27 55	—	B.	Steady air.
—	—	Bisection	10 29 34	—	B.	
—	—	Disappearance.	10 31 30	10 31 —	B.	
—	I. Oc. D.	Last seen	10 32 45	10 31 —	H.	Definition fair.
Apr. 18	I. Tr. E.	Bisection	10 2 41	—	B.	Rather unsteady.
—	—	External contact.	10 4 23	10 2 —	B.	
Apr. 19	I. Ec. R.	First seen	7 43 15	—	B.	Twilight.
—	—	Bright	7 44 44	7 43 43	B.	Rather unsteady.
—	I. Ec. R.	First seen	7 44 21	—	J.	
—	—	Bright	7 45 55	7 43 43	J.	Twilight.
Apr. 21	III. Tr. I.	Internal contact.	9 12 0	9 11 —	E.	
—	III. Tr.	On Central Meridian.	10 15 0	—	E.	Bright circular image of satellite plainly seen on N. temperate band; a dark brown shadow on W. side of spot.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
Apr. 25	I. Tr. I.	External contact.	9 32 0	9 33 —	H.	Conditions fair.
—	—	Internal contact.	9 35 0	—	H.	
May 2	III. Oc. D.	One diam. from limb.	2 6 0	—	M.	
—	—	External contact.	2 15 30	—	M.	
—	—	Gone	2 24 30	2 20 —	M.	Very gradual.
—	III. Oc. R.	Easily visible.	4 54 0	—	M.	
—	—	Clear	5 4 30	5 2 —	M.	
—	III. Ec. D.	Fading	5 36 0	—	M.	
—	—	Semi-oval	5 41 0	—	M.	
—	—	Gone	5 46 25	5 45 35	M.	Gradual.
May 5	I. Ec. R.	First glimpse.	5 57 36	—	M.	No change in shape.
—	—	Fully bright.	5 59 48	6 0 46	M.	
—	II. Tr. E.	Contact.	9 34 0	9 34 —	K.	Satellite seemed unusually long in getting away.
—	—	Quite clear	9 40 0	—	K.	
May 6	I. Sh.	On Central Meridian.	2 6 0	—	M.	Very black.
—	I. Tr. I.	Internal contact.	2 22 0	—	M.	Elongated E. and W.
—	—	Off	2 27 0	2 29 —	M.	
May 7	II. Ec. R.	First glimpse.	6 13 52	—	M.	
—	—	Fully bright.	6 20 30	6 19 31	M.	
May 11	I. Sh.	On Central Meridian.	9 31 0	—	B.	Wind, but clear. Earlier than predicted in E.M.
May 12	I. Ec. R.	First seen	7 56 30	7 55 11	H.	Observed when the sun had hardly set. Though it took 2^m to come into full view. It was then in conjunction with II.
—	II. Tr. I.	External contact.	9 24 0	9 23 0	H.	Definition fair.
—	—	Internal contact.	9 27 0	—	H.	
May 13	I. Tr. I.	External contact.	2 1 0	—	M.	
—	—	Internal contact.	2 3 30	2 2 —	M.	
—	—	On disk	2 10 0	—	M.	Still bright, elliptical E.W.
—	—	Do.	2 25 0	—	M.	Just visible, brighter than disk.
—	—	Do.	3 57 0	—	M.	
—	I. Tr. E.	Internal contact.	4 13 0	—	M.	Slight ellipticity.
—	—	External contact.	4 16 0	4 18 —	M.	
—	I. Sh.	On Central Meridian.	3 57 30	—	M.	Small; round.
—	I. Sh. E.	Internal contact.	5 8 5	—	M.	Very black.
—	—	Off	5 12 5	5 17 —	M.	
—	III. Sh.	On Central Meridian.	0 52 30	—	M.	Black penumbra.
—	III. Sh. E.	Internal contact.	1 58 30	—	M.	Suspected.
—	—	Off	2 8 30	2 15 —	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
May 14	II. Oc. D.	First contact.	4 19 0	—	M.	
—	—	Gone	4 22 30	4 22 —	M.	
—	II. Ec. R.	First seen	8 55 28	8 56 6	B.	
—	—	Bright	8 57 36	—	B.	Steady air.
May 16	II. Tr. E.	Off	1 13 0	1 8 —	M.	
—	II. Sh.	On disk	1 15 0	—	M.	On S. component of S. temperate band.
May 18	I. Tr. I.	First contact.	9 25 0	9 24 —	K.	For 10m afterwards the satellite was brilliant.
—	—	Well on	9 27 0	—	K.	
—	I. Tr. I.	External contact.	9 21 37	9 24 0	B.	Good definition.
—	—	Bisection	9 24 19	—	B.	
—	—	Internal contact.	9 26 47	—	B.	
—	I. Tr. I.	First contact.	9 23 0	9 24 —	H.	
—	—	Internal contact.	9 26 0	—	H.	
May 21	I. Ec. R.	Fully bright.	4 18 0	4 18 25	M.	
May 23	IV. Oc. D.	Contact.	9 34 0	10 17 —	E.	The approaching satellite appeared round and bright, gradually fading as it neared occultation on the polar region of Jupiter. Reappeared a little higher; very faint.
—	IV. Oc. R.	Glimpsed	11 43 0	11 7 —	E.	
May 28	II. Oc. D.	First contact.	9 13 0	—	H.	Definition poor.
—	—	Gone	9 16 0	9 17 —	H.	
May 29	I. Tr. I.	Internal contact.	0 14 0	0 10 —	M.	
—	I. Tr.	On disk	1 0 0	—	M.	Visible as a grey spot.
—	—	On Central Meridian.	1 14 30	—	M.	Fading.
—	—	On disk	1 47 0	—	M.	
—	—	Do.	2 5 0	—	M.	Invisible.
—	—	Do.	2 11 0	—	M.	Satellite reappeared; faint.
—	—	Do.	2 17 0	—	M.	Satellite suddenly bright.
—	I. Tr. E.	Internal contact.	2 2 0	—	M.	
—	—	External contact.	2 23 0	—	M.	Satellite circular.
—	I. Sh. I.	Do.	1 18 30	—	M.	
—	—	Internal contact.	1 21 0	—	M.	
—	I. Sh.	On Central Meridian.	2 24 0	—	M.	Shadow appeared larger than the grey satellite.
May 30	I. Ec. R.	First glimpsed.	0 38 50	—	M.	
—	—	Fully bright.	0 41 30	0 41 42	M.	
June 1	I.	Near elongation.	3 50 ±	—	M.	Unusually bright.
June 4	I. Oc D.	External contact.	4 38 7	—	M.	
—	—	Gone	4 41 2	4 42 —	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1898.			h m s	h m s		
June 5	I. Tr. I.	Before Ingress.	2 0 0	—	M.	Bright. Pale yellow.
—	—	External contact.	1 55 45	—	M.	
—	—	Internal contact.	2 1 45	2 2 —	M.	Circular.
—	I. Tr.	On disk	2 4 0	—	M.	Equatorial region of Sat. brighter than poles.
—	—	Do.	2 9 0	—	M.	Elongated p. edge.
—	—	Do.	2 19 0	—	M.	Barely perceptible.
—	I. Sh.	Do.	4 50 0	—	M.	Shadow intensely black.
June 8	I.	Against sky	1 35 2	—	M.	Satellite unusually faint.
June 9	IV. Oc. D.	First contact.	2 21 30	—	M.	Satellite very dull.
—	—	Last contact.	—	2 47 —	M.	Not seen.
—	IV. Oc. R.	First contact.	4 3 30	4 17 —	M.	Difficult, owing to small angle with planet.
—	—	Clear	4 31 —	—	M.	
June 10	I. Tr. I.	External contact.	9 25 21	—	B.	Steady air.
—	—	Bisection	9 27 39	9 27 —	B.	
—	—	Internal contact.	9 30 11	—	B.	
—	I. Tr. I.	External contact.	9 23 0	—	H.	Definition fair.
—	—	Internal contact.	9 26 0	9 27 —	H.	
—	I. Tr. I.	External contact.	9 25 0	—	K.	Satellite seen well on the limb at $9^h\ 35^m$.
—	III. Tr. I.	Do.	10 17 52	—	B.	Air currents.
—	—	Bisection	10 23 24	10 23 —	B.	
—	—	Internal contact.	10 27 34	—	B.	
—	III. Tr. I.	External contact.	10 20 0	—	H.	
—	—	Bisection	10 26 0	10 23 —	H.	
—	—	Internal contact.	10 31 0	—	H.	
June 10	III. Tr. I.	First contact.	10 21 30	—	K.	
—	—	Well on	10 27 0	10 23 —	K.	
June 11	I. Ec. R.	First seen	10 2 18	10 2 33	B.	Steady.
—	—	Bright	10 3 54	—	B.	
—	I. Ec. R.	First seen	10 30 0	10 2 23	H.	Difficult to observe owing to cirrus clouds covering the planet.
June 13	II. Sh.	On Central Meridian.	1 23 0	—	M.	Small round and black.
—	—	On disk	2 35 —	—	M.	On passing off elongated.
June 21	I. Tr.	On Central Meridian.	1 27 —	—	M.	Circular grey dot.
—	I. Sh. I.	Internal contact.	1 34 25	1 34 —	M.	
—	I. Sh.	On disk	1 50 0	—	M.	
—	III. Ec. D.	Fading	9 42 45	9 41 11	J.	
—	—	Gone	9 47 10	—	J.	
June 22	II. Ec. R.	First seen	11 16 45	11 15 25	J.	
—	—	Bright	11 20 5	—	J.	

Date.	Phe-nomena.	Phase.	Observed G.M.T.	Pre-dicted G.M.T. (N.A.)	Observer.	Remarks.
			h m s	h m s		
June 28	I. Tr. I.	External contact.	2 11 0	—	M.	
—	—	Internal contact.	2 13 20	2 13 —	M.	Circular and bright.
—	I. Tr.	On disk	2 19 0	—	M.	Elongated. E. and W.
—	—	Do.	2 22 0	—	M.	Do. Bright.
—	—	Do.	2 25 0	—	M.	Do. Bright.
July 4	I. Ec. R.	First seen	10 16 20	10 15 50	J.	
—	—	Bright	10 18 30	—	J.	
July 6	I. Oc. D.	First contact.	1 11 50	—	M.	
—	—	Gone	1 15 5	1 17 —	M.	
July 20	I. Ec. R.	—	8 36 40	8 34 25	J.	Very strong twilight.

CONJUNCTIONS OF SATELLITES.

Mar. 22	I.	II.	—	—	B.	
„ 22	I.	II.	—	—	H.	
May 6	II.	III.	—	—	H.	III. being to the N.

Observers.

B. = BRIDGER, T. H., Farnborough, Hants, 4-O.G.
E. = ESSAM, EDWARD, Billingborough, Lincolnshire.
H. = HALL, WALTER J., Lindum House, Nantwich.
J. = JOHNSON, REV. S. J., Melplash, R.S.O., Dorset, $3\frac{3}{4}$-O.G.
K. = KILLIP, REV. R., St. Anne's-on-Sea, Lancashire, 5-O.G.
M. = MOLESWORTH, CAPT. P. B., Trincomalee, Ceylon.

In closing this part we subjoin the following remarks by *Mr. H. J. Townshend* on Satellite I. He states he saw it of a reddish brown colour when on the disk of the Primary. He also refers to the well known fact that, *in transitu*, it is often lost to sight, and that it has been often seen grey and dark grey in colour. The fact of its being seen brownish was confirmed by another observer independently at the same time. Mr. Townshend thinks it suggests some variation in the physical condition of certain areas of Jupiter, since it could not be optical or the result of complementary colouration.

Capt. Molesworth in his copious and valuable returns has given an interesting *resumé* of the satellite observations and studies. We much regret that the limitations of space necessitate a mere abstract, especially as the subject of satellite markings is a moot question among those whose keenness of sight and instrumental equipment qualify for the work. We may hope that

Capt. Molesworth may give to the astronomical world, the whole of his observations on this difficult and important department of scientific enterprise. Meanwhile this brief thesis, chiefly in his own terse language, is here presented as a stimulus to exertion in these fascinating pursuits.

Io,—*I.*

"No markings whatever have been seen on I. whilst against " the sky, in which position it appears absolutely circular, and " of a bright pale yellow, only inferior in albedo to II. During " transits at ingress and egress this satellite has often been seen " to become elongated when just inside the limb, often attaining " a very high degree of ellipticity, 1·20—1·35. This was noted " on almost every occasion, (*e.g.*, April 4th, May 6th–13th, &c.) " and was not easy to explain at first. On June 5th, however, " with a power of 600, the definition being very sharp, the " reason for the apparent elongation was clearly seen at ingress. " The equatorial portion of the satellite is seen as a bright " ellipse on the duller circular disk, for as the satellite in the " course of transit passes in front of the gradually brightening disk " of Jupiter, the faint circle ceases to be visible against the back- " ground, and only the bright equatorial ellipse can be made out. " This is generally visible from 15 to 20 minutes after the first " contact, and becomes fainter and more diffused as the satellite " advances. About 20 to 25 minutes after first contact the " satellite becomes invisible, reappearing a few minutes later as " a grey spot, which gradually darkens as it nears the C.M. " I have, however, never seen it darker than a dull grey (about " the same darkness as the normal dark spots of the S. equatorial " spots), and never black. It also generally appears much smaller " than one would expect. The same appearances take place in " the reverse order at egress, except that the satellite seems to " remain grey rather longer, and the change from dark to light " seems to be more sudden than at ingress. The explanation of " these changes is, I think, that the axis of rotation of I. is ap- " proximately parallel to that of Jupiter, the poles of the satellite " being dull and deficient in reflective power, compared with the " equatorial regions. Two of my observations this year seem to " point to the possibility of variation in the light of this satellite. " It was seen on June 1, 1898, near elongation unusually bright, " and on June the 8th in haze I considered it after a careful " comparison with the other satellites unusually faint. I would " suggest that careful observations be made, preferably by an " observer accustomed to variable star work, with a view to " confirming this supposed variability and the discovery, if pos- " sible, of its rotation period. The shadow of I. in transit is " neat, sharp, circular, and intensely black. I have once or twice " suspected a slight penumbra."

Making due allowance for the inferiority of English air to that of Ceylon, other observers, including the Director, can substantially confirm nearly all the above, with reference to satellite variability.

Europa,—II.

"The reflective power of II. seems to surpass any of the others; " when close to either III. or IV. it forms a great contrast, " especially with the latter. No ellipticity has been noticed, nor " have markings of any kind been detected during these obser- " vations. It usually appears sharply defined, and of a brilliant " pale yellow, I do not remember having seen a dark transit of " this satellite. The shadow during transit appears smaller than " one would expect, and, I think, is darker at the centre than at " the edges, but I have not been able to trace any defined " penumbral ring. It was suspected as slightly elongated N. and " S. on June 17."

Ganymede,—III.

"This satellite is by far the largest of the four, but inferior in " 'albedo' to I. and II. It is, however, immensely superior " to IV. In colour it is usually of a pale primrose yellow. " Markings were distinctly seen on the disk of this satellite, both " during transit and against the sky." This interesting feature is shown in many careful sketches. At first nothing definite is shown on the sketches, except faint equatorial shades and suspicions of darker spots on transverse markings. On April 7th, however, "the curtain rose" during transit (to quote Mr. Douglas's expressive simile) M.N., LVIII., 7 May 1898), and a darker streak inclined to the equatorial belt was distinctly seen. (A chart of the markings is given, which it is hoped may be reproduced by the Council on some future occasion.) This had been seen, but not so well on the previous night, and observations on successive nights, and different hours of the same night, showed a direct axial rotation in about 23 hours. Independent drawings were obtained afterwards whenever possible.

"And the same marking was again picked up and carefully " followed whilst visible. A second similar marking was also " detected about 110° of longitude after the first. These were " carefully checked, and central meridian transits obtained with " as much accuracy as the minuteness of the object would permit. " The rotation period was deduced independently from the obser- " vations of each of these two spots (called A and B), and the " periods thus obtained were found to be in very close agreement " with each other. The mean apparent rotation period from " these two spots was found to be $22^h\ 59^m{\cdot}0315$, equalling a " mean sidereal rotation period of $22^h\ 59^m\ 10^s{\cdot}65$." The full data from which this period is obtained are given in a tabular form, here omitted from want of space. On the basis of this rotation period Capt. Molesworth has worked out a complete ephemeris. It is omitted for the same reason. The Director will give a copy to any who can use it. Capt. Molesworth has also worked out the central meridian of the whole of the 66 sketches of the satellite taken during the observations.

Capt. Molesworth further says, "As far as I can judge the " axis of rotation is inclined about 7c° or 8o° to the plane of " the primary's equator, the N. pole being slightly turned

" towards us during the observations. In addition to the dark " markings a very white minute (polar ?) spot has been seen on " a good many occasions, as nearly as I can judge, at the N. " end of the axis of rotation. I have fancied this spot slightly " excentric."

Capt. Molesworth naturally says, "I feel a certain amount of " diffidence of these results, in view of the fact, that Lowell and " Douglass, with far more perfect means, have come to entirely " different conclusions, while Prof. Pickering with the Lick 36-in. " can only see faint equatorial shades, and the polar spot. I am, " however, quite certain of the reality of these markings, and " have actually seen the displacement from hour to hour on the " same night. When the definition is 5 on my scale, the equatorial " belt can usually be made with a power of 340, and I have " detected it once with a power of 305. I may also point out " that my instrument, although small beside the colossal telescopes " at Lick and Flagstaff, is very perfect in its way, and very " massively mounted. The air here is often magnificent for " planetary detail, and the satellite was observed continually on " every occasion when definition was good, for nearly three " months.

"The whole of the 66 drawings of the satellite thus obtained " agree very well among themselves, considering the minuteness " of the disk, and the difficulty of estimating the exact centre. " The connected ephemeris was not made out until after all the " observations were finished, and in no case was even the approxi- " mate longitude calculated until I had finished the sketch. " Probably Mr. Douglass' markings and mine are the same, but " our representations of them are each tinged with the personal " peculiarities of the observer. I cannot account for his adoption " of the longer rotation 'period,' as under favourable conditions " the shift of the markings from hour to hour can be well seen " with a power of 500 or 600.

"When near opposition the disk of III. was frequently sus- " pected as elliptical, the longer axis not always lying the same " way, and its direction appearing to have no relation either to " its rotation period or to its period of revolution round Jupiter. " These observations are given in tabular form, but their discordance " seems to indicate the possibility of optical or atmospheric causes.

"The shadow of III. during transit is very large and black, " I have seen it surrounded with a narrow penumbral ring, and " have suspected an irregular extension of this ring in a north " preceding and south following direction." (*Drawing of this is given in the notes. Also a complete chart of the markings.*)

Callisto,—IV.

Second to III. in size, but by far the faintest of the four, the contrast with a high power being very great when IV. is in the same field with another satellite. The colour is a dull pale blue.

Markings were detected on it when against the sky, but these were only visible under very favourable conditions, owing to the faintness of the disk, and were at once blotted out by the slightest haze or bad seeing.

The most distinct marking was an ill-defined white polar one at the S. edge of the disk, from which faint shades usually diverged. A very faint lightening was also suspected once or twice at the s. p. limb. "I suspect a fairly rapid rotation, pro- "bably more rapid than that of III., but my data are insufficient "to make a wild guess at its period." The disk of IV. was suspected elliptical on several occasions near opposition, the inclination of the major axis being fairly constant, making the angle roughly 90° with the equator of Jupiter. The shadow on the only occasion when it was seen was not altogether on the disk, at egress a distinct penumbra was visible, but not when near C. M.

PART 5.

In closing this "Memoir" the Director would like to call special attention to the comprehensive papers by W. F. Denning, F.R.A.S., on the history of the Great Red Spot from its earliest date to its recent aspect, and on the rotation periods of other important spots and markings in No. 9, of Vol. 58, of the "Monthly Notices" of the Royal Astronomical Society. The same number contains also a valuable report of observations of the planet by Mr. Gledhill at Bermerside, Halifax. This paper deserves close study, and may well form a model for the returns of every Member of the Section, especially to those who are the possessors of a micrometer.

As a general view of the aspect of the planet's disk has been given in Part 2, instead of the usual closing *resumé* we prefer giving extracts from some of the more formal returns of the Members of the Section.

1st. THE GREAT RED SPOT.—*Capt. Molesworth's* remarks are given in a separate paper (*supra*).

Mr. Essam.—"The Great Red Spot was well seen on April 15, 1898. It was of a ringed appearance, having lost much of its pinkish tint, appearing now of a light grey colour. The aureola was very white and distinct."

Mr. Banaster.—"On the 17th of April I had a beautiful view of the Great Red Spot. At times I fancied I could trace the complete oval, but the eye may have guessed at the more indistinct preceding portion unconsciously. I am inclined to think it faded off, or merged into a bright streak preceding the spot, and so I have tried to show it on the sketch. Some rather rapid change must have taken place in the 'bay.' For this spring the following has been steep and sharp, but on April 17, when the spot was so well in view, the preceding shoulder was the more pronounced."

The Rev. T. E. R. Phillips.—"This, the most interesting feature of the Jovian disk, was carefully looked for, and though in poor air extremely difficult, and usually invisible (with the exception of a fragment at its following end), was several times

well seen when definition was good. At first the spot presented the appearance of a dusky oval ring, rather darker at its S.F. end, but as the apparition advanced, the ringed aspect seemed changed into the appearance of a very faint oval shading, gradually darkening to the S.F. portion. The colour of the spot was grey, not a trace of red being suspected, and throughout the apparition the spot was in contact with the S. temperate band. The bay in which the spot lies was well defined, the following shoulder as during the previous apparition being deeper and very much darker than the P. shoulder. The material within the bay was exceedingly brilliant. The spot itself never seemed central in the bay, but always displaced towards the F. end, its C.M. transits appearing to take place about three or four minutes later than those of the centre of the bay. Sketches accompany this account. Changes, otherwise than in colour, may fairly be inferred from the above account."

EQUATORIAL ZONE.—*Capt. Molesworth.* "The general tint of the equatorial zone is an orange yellow, shading in parts almost to brown, and lightening to all degrees of white at the brighter parts, from a dull yellowish white to a brilliant, almost phosphorescent, milk white. The delicacy of these gradations and the softness of the shading of the wisps quite defy reproduction. I can imagine no more beautiful sight than this region when studied with a large aperture under really good conditions, and it is absolutely impossible to give any idea of the marvellous detail visible. The brighter parts almost invariably occur in the zone immediately N. of the darkest parts of the N. edge of the S. equatorial belt. The faint wisps crossing this zone are difficult objects as a rule, and require sharp definition to see them well. They are, I think, rather darker this year than last, but are very fugitive objects, and do not appear to be at all permanent. They almost invariably take their rise in one of the dark spots in the N. edge of the S. equatorial belt, and cross the equatorial zone at almost any angle, generally in a straight line, but sometimes more or less curved. As a rule, adjacent ones are more or less parallel, but this is not an invariable rule, and two or more wisps frequently diverge from the same spot. The wisps are, as a rule, darkest in the south, fading gradually northwards, and making the equatorial zone under moderate definition appear as if it was darkest to S. and shaded away gradually to the N. In some cases the wisps appear to terminate at the faint N. central equatorial belt, and not to reach the N. equatorial belt. They appear to be a faint grey, but colour in such delicate objects is doubtful."

The Rev. T. E. R. Phillips.—"The whole of this zone, with the exception of the brilliant white spots, was of a deep orange, and at times almost of a coppery hue, especially near its N. edge. The colour was most marked, and appeared decidedly stronger than during last apparition. For some months there was seen a dusky line or band running close to the N. equatorial belt and parallel to it, and apparently physically connected with it, by material of a somewhat ruddy colour. It was difficult to say whether or not this band was the old S. component of the N.

equatorial belt, which had survived from the previous year. Later on, however, this dusky streak was observed to retreat gradually further and further from the N. equatorial belt, and in the end, though still perhaps somewhat N. of the equator, seemed to be identical with the well-known faint equatorial belt. The white spots detached from the S. equatorial belt varied a good deal in size and appearance, sometimes being small and well defined, and at other times being large and much diffused.

"The wisps seen on the equatorial zone were, generally speaking, neither quite so numerous nor so attenuated as during the apparition of 1896–97. Now and then a narrow transverse line was seen connecting the equatorial belts, but as a rule the wisps appeared as diffused dusky markings. One interesting point was observed in connexion with these shadings. For some months their trend seemed to be almost in every case from S.P. to N.F.; subsequently they were observed to be generally perpendicular to the belts, and at the end of the apparition the direction in most cases was from S.F. to N.P."

Mr. Harold Smith.—"The colour of the equatorial zone was reddish (possibly partly accounted for by haze). A wisp was seen near the preceding limb towards the N. equatorial belt. The whole of the equatorial region was very hazy and cloud covered with white spots near the equator."

Mr. Charles Smith.—"There were two dark shadings on the equatorial zone, one on each side of a rift in the S. equatorial belt." Probably diffused wisps. He also speaks of faint shadings connecting the equatorial belts. Also that the zone was very yellow, with faint projections into the zone from the S. equatorial belt. (*See* Mr. C. Smith's excellent drawings in the Album.)

Mr. Wadmore speaks of the equatorial zone as dusky pink.

Other observers briefly corroborate the more prominent features of this interesting portion of the planet's disk.

THE SOUTH EQUATORIAL BELT.—*Capt. Molesworth.* "Colour, a fine warm grey, deepening at the following shoulder and the part following into an almost ruddy purple. It is apparently the most disturbed region of the whole planet, especially as regards its N. edge. This activity appears to be at a maximum, both for light and dark spots, in the region just preceding the Great Red Spot, and at a minimum just following it. The changes in the belt take place with bewildering rapidity, and the identification is most difficult. The belt is rifted almost continuously throughout, the rift being of varying width and brightness, and changing rapidly from night to night. The central rift breaks out here and there into the equatorial zone, appearing to force back and contort the dark matter on either side of the 'break-out' (called rifts by some observers). The greatest activity in the belt appeared to occur at the end of May and the beginning of June. In spite of numerous observations for longitude, I was unable to detect any uniform drift in the markings in this belt. The juxtaposition of the brightest and darkest marking is dealt with elsewhere." Space forbids the insertion of these observations.

The Rev. T. E. R. Phillips.—"As usual this prominent belt was of a deep red or chocolate colour, and divided by a narrow rift of white material, widening considerably as it approached the P. shoulder of the Red Spot Bay into two components having very different rotation periods and widely dissimilar in appearance. The N. component was in a state of considerable disturbance, being interrupted by sundry rifts, and otherwise broken up by numerous dark and white spots, projecting into the equatorial zone. These white and dark spots were usually arranged alternately. (A discussion of their rotation is found in Part 3.) It may, however, be stated here, though tentatively only and with considerable doubt, that the white spots appeared to be at a somewhat higher level than the dark, there being at least one instance in which a white spot seemed to overtake, pass over, and obliterate its P. dark neighbour. The S. component of the belt was much quieter than the N., although one or two definite markings were seen, and apparently indicated a rotation slightly quicker than System II. These were bright spots on the rift dividing the two components of the belt. These spots were sometimes of great brilliancy, and owing to the difference in the rotation of the dark material bounding them, exhibited rapid and striking changes of form." (Here follows four careful pencil sketches of these phenomena, which it is hoped Mr. Phillips will still further elaborate and issue in a specific article for the "Journal.")

The Rev. T. H. Foulkes sends sketches of this belt which corroborate many of the above remarks, especially the alternating of white and dark spots and the activity of the N. edge of the belt.

Mr. Bridger.—"The S. equatorial belt is duplex in some parts. The preceding shoulder being much less definite than last year, and the belt is divided (I think) all round, the following shoulder being dark." Several other observers corroborate the above as to duplicity of belt, the alternation of dark and light markings on the N. edge, and the general disturbance of the N. component. *Vide* the drawings of Messrs. Essam, Charles Smith, Wadmore, Harold Smith, and other observers.

THE N. EQUATORIAL BELT.—*Capt. Molesworth.*—"Dark but very narrow, the N. edge being sharp, the S. edge being diffuse, and often shading away insensibly into the wisps. The colour is a steel grey, with possibly a faint purple tinge, merging near some smoky streaks into a brown grey. It is very uniform in darkness and density, with no striking irregularities, with only here and there a tendency to form darker knots, which sometimes give the northern edge a wavy appearance; one of these knots generally occurs as the preceding edge of each of the streaks already mentioned."

The Rev. T. E. R. Phillips.—"There was a striking diminution in the latitude and in the intensity of this belt. The alteration in the latitude was observed visually only, but was very apparent. As regards the diminution in intensity it will be remembered that during the previous apparition the N. equatorial belt had developed in the most remarkable manner and with

wonderful rapidity into quite the most disturbed region of the disk. The disturbances were, however, comparatively short-lived, and some time before the planet was lost in the sun's rays the belt showed signs of returning to a state of quiescence. These indications were abundantly fulfilled, for in the late autumn of 1897, as soon as the planet emerged from the sun's rays sufficiently for observations to be recommenced it was found that the broad and much disturbed belt of the previous apparition had again dwindled down to a comparatively peaceful looking belt."

Mr. Banaster.—"The N. equatorial belt has been seen duplex on many nights, and wavy and mottled throughout. The N. edge has been better defined than the S. I frequently saw a well-defined line running N*f* in a slanting direction well to the edge of the disk. I am convinced this line must have run spirally round the planet and joined the N. temperate band, which from being pretty well invisible (only a hair line in good air) became afterwards quite an easy object." Mr. Banaster uses a very superior equatorial.

The Rev. T. H. Foulkes speaks of the N. equatorial belt as very irregular on its S. edge, and of a connexion between the N. edge of the belt and the spot A. on the N. tropical zone. This connexion is shown in three sketches of that portion of the disk.

Mr. Bridger.—"The N. equatorial belt strongly suspected as duplex, especially the following end. Also that the width has diminished, and that the division was increasing so that the S. portion had encroached on the equatorial zone."

Mr. Wadmore speaks of the irregularity of the N. equatorial belt with faint excrescences on its N. edge.

SOUTH TROPICAL ZONE.—*Capt. Molesworth.*—"Regular and intensely white, the most uniformly white portion of the whole planet (except the brilliant white spots of the S. equatorial belt and the red spot bay). Its breadth is very constant. It appears to be liable to the formation of minute white spots, which are very slightly lighter than the ground of the zone, and are correspondingly difficult to see well."

This portion of the disk has been overlooked of late, but it is full of interest, especially in the region of the Red Spot.

NORTH TROPICAL ZONE.—*Capt. Molesworth.*—"This zone is intensely white in the same longitude as the Red Spot, but as a rule has the rest of its southern portion more or less merged with yellow. The yellow colour is clearer and brighter than the tint of the equatorial zone, and is generally more pronounced in the neighbourhood of the smoky streaks, A, D, &c." These streaks are fully dealt with in Part 5.

The Rev. T. E. R. Phillips.—"This zone, though still very bright, was much less so, and not so brilliant as during the previous apparition, when it was unquestionably the brightest part of the disk. An interesting feature of this region was a narrow line running parallel to the N. equatorial belt. This line was fairly conspicuous during the early part of the apparition, but either from decreasing intensity, or bad seeing, subsequently

became very difficult, and at the close of the apparition invisible. The three prominent elliptical or elongated dark spots (A, B, C) (*see* tables) were really intensifications of the dark line above mentioned, but the spot A at times appeared connected by a narrow ligament with the N. edge of the N. equatorial belt. The drawings of Mr. Foulkes corroborates this. Whether the connexion was complete, however, may be doubted, as the rotation periods of the spot and belt were so different (*see* the tables), from which it may be seen that there has been a marked increase in the rate of the drift of the surface material of this zone."

All the observers write of or draw one or more of these dark streaks, and they are fully discussed in the tables and shown in the drawings.

Mr. Bridger corroborates the connexion between the spot A and N. equatorial belt.

SOUTH TEMPERATE BAND.—*Capt. Molesworth.*—"Dark and knotted, the colour being almost always a faint blue. The belt broadens out at several points, and has been sometimes seen double at these broader places. The outline of the southern edge appears to be slightly distorted in the neighbourhood of certain spots. This band is certainly the darkest and most important of the minor belts."

The Rev. T. E. Phillips.—"When seeing was good this belt was distinctly double; at all events, in places. It was not uniform in breadth or intensity, but contained a number of dark and bright spots, which moved with much greater rapidity than the Great Red Spot. It was interesting to watch one bright spot in particular gradually drifting past the latter" (*see* drawings).

Mr. Banaster.—"I have fancied several times that the S. temperate band was double. It has been well seen all through the spring."

Mr. Bridger.—"The S. temperate band has generally appeared regular and uniform, though of varying width and distinctness in different longitudes."

Mr. Harold Smith.—"This band was narrow in longitude, $\pm$ 157°, but widening considerably E. and W."

NORTH TEMPERATE BAND.—*Capt. Molesworth.*—"This band has almost disappeared, and can only be seen well under good definition. It is very faint throughout, straight and narrow. It is rather darker and broader near streak A, but even there it is extremely faint."

All the other observers, by drawings and description, corroborate the above as having no distinctive features.

THE N.N. TEMPERATE BAND.—*Capt. Molesworth.*—"Fairly dark and distinct, of a delicate bluish gray. Double for a considerable distance, and in parts inclined at a slight angle to the other bands. In one or two places shoulders were formed, and in one instance a definite darker bay enclosing a dark elongated spot (E), rather like a minature Red Spot, and apparently due to similar causes."

The above statement is most interesting and important, and is in part corroborated by the drawings of other observers, especially by Messrs. Banaster and Phillips.

SOUTH POLAR REGIONS.—*Capt. Molesworth.*—"Smooth and uniform as a rule, with less appearance of striation than the N. polar regions. The tint is generally of a pale grey, with a faint tinge of yellow, and once or twice I have fancied a very faint bluish tinge."

Mr. Banaster speaks of this region as of indigo grey.

NORTH POLAR REGIONS.—*Capt. Molesworth.*—"Usually of a pale bluish grey, seen, however, on rare occasions with a distinctly yellowish tinge. Under good definition it frequently presented a lined or striated appearance, as if consisting of innumerable parallel lines. This appearance was most marked in longitude 330° — 60°."

Mr. Banaster speaks of this region as much darker than the south.

Drawings and many observers corroborate these aspects of both polar regions, but they need to be made a specialité.

W. R. WAUGH,
Director of the Section.

1899, February 23.
Portland.

OBSERVATIONS OF JUPITER, 1898.

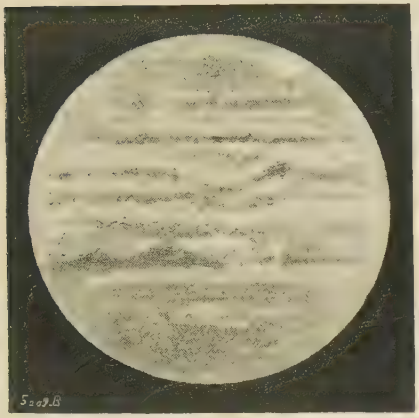


Fig. 1. H. Wright, 8½ in. Spec.
1898, May 25, 23 h. 30 m. Long. 3°.

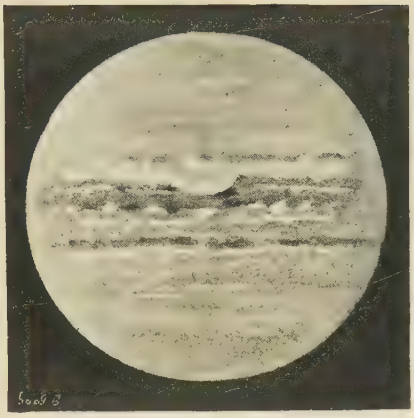


Fig. 2. W. R. Waugh, 4.5 in. O.G.
1898, April 15, 10 h. Long. 7°.

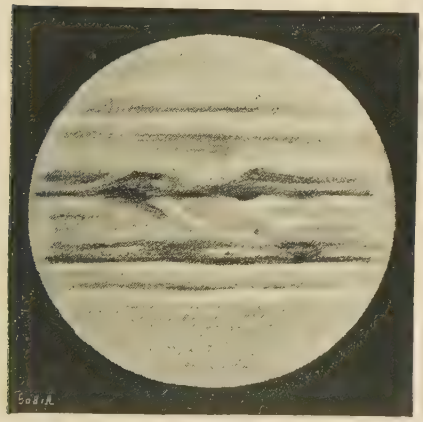


Fig. 3. H. F. Smith, 6½ in. Spec.
1898, April 8, 9 h. 30 m. Long. 19°.

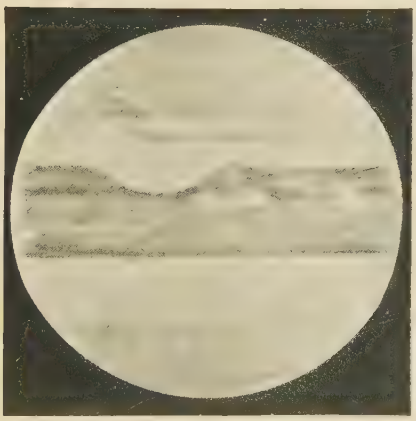


Fig. 4. P. B. Molesworth, 12½ in. Spec.
1898, May 3, 5 h. 41 m. Long. 33.8°.

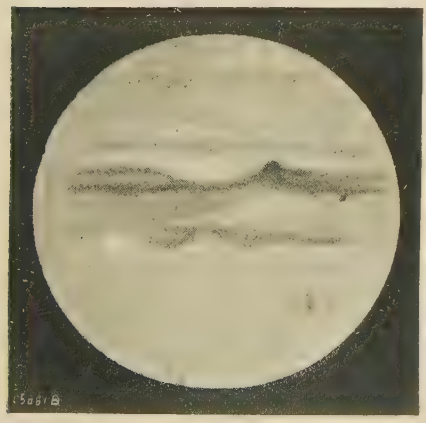


Fig. 5. C. F. Smith. 5¼ in. Spec.
1898, Feb. 16, 13 h. 5 m. Long. 36°.

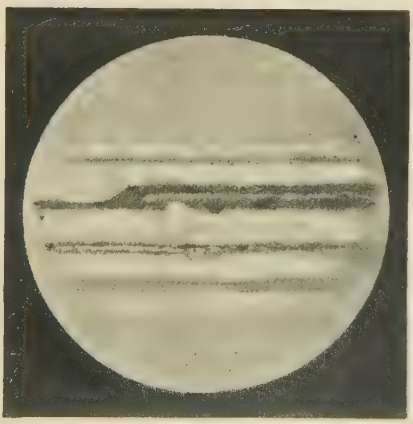


Fig. 6. H. Y. Childs, 4.5 in. O.G.
1898, April 23, 8 h. 10 m. Long. 63°.

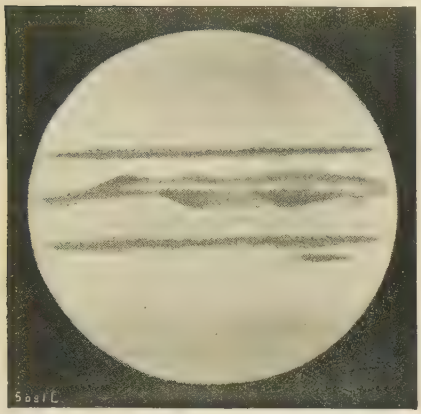


Fig. 7. A. Mee, 8½ in. Spec.
1898, June 17, 8 h. 45 m. Long. 67°.

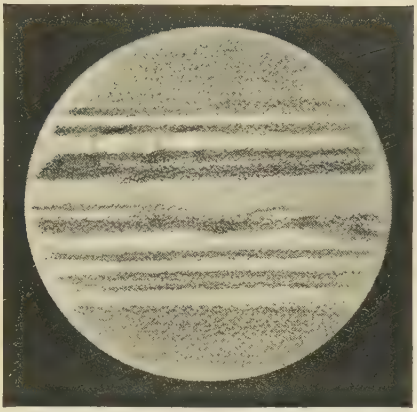


Fig. 8. D. Smart, 10½ in. Spec.
1898, April 23, 8 h. 30 m. Long. 72°.

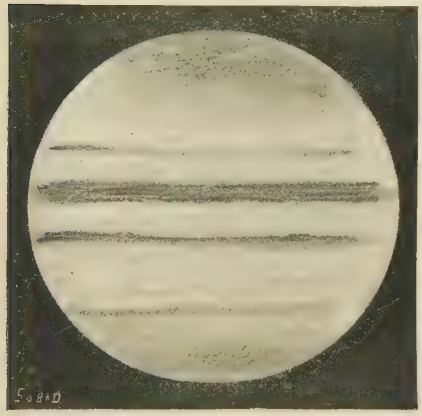


Fig. 9. Arthur Cottam, 12½ in. Spec.
1898, April 16, 8 h. Long. 84°.

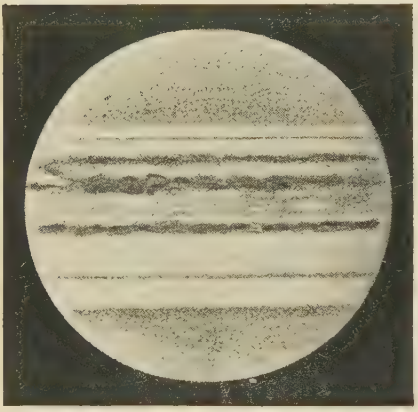


Fig. 10. J. Wykes, 4.5 in. O.G.
1898, June 5, 9 h. 35 m. Long. 94°.

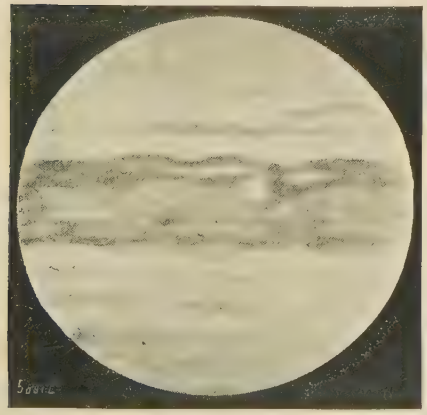


Fig. 11. P. B. Molesworth, 12½ in. Spec.
1898, May 18, 5 h. 5 m. Long. 107.8°.

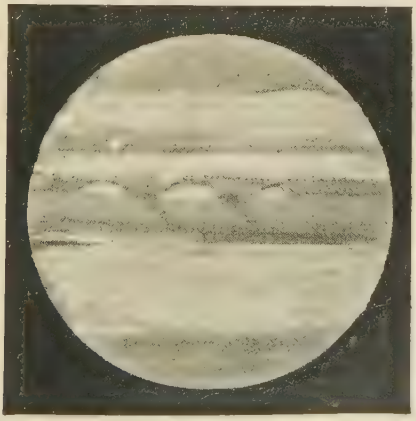


Fig. 12. Robert Killip, 5 in O.G
1898, June 10, 10 h. Long. 143°.

OBSERVATIONS OF JUPITER, 1897-1898.

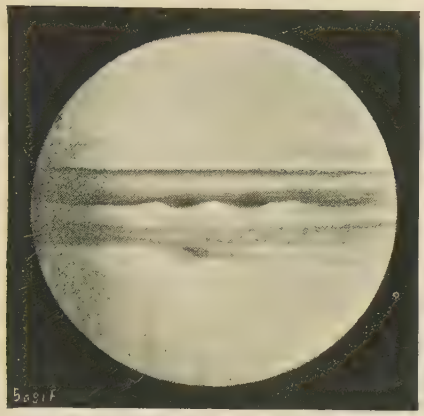


Fig. 13. G. Banaster, 4 in. O.G.
1898, March 6, 11 h. Long. 151°.

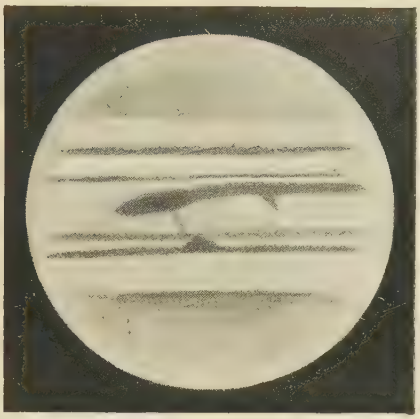


Fig. 14. J. W. Meares, 9¼ in. Spec.
1897, December 3, 13 h. 14 m. Long. 205°.

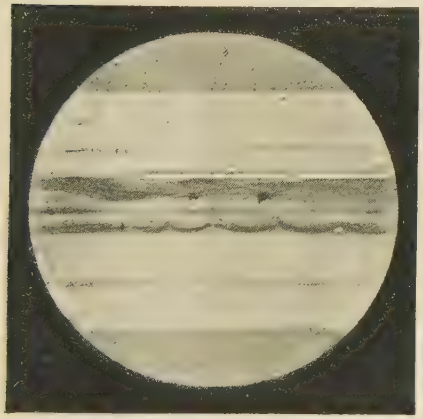


Fig. 15. H. J. Townshend, 9½ in. Spec.
1898, April 21, 11 h. Long, 243°.

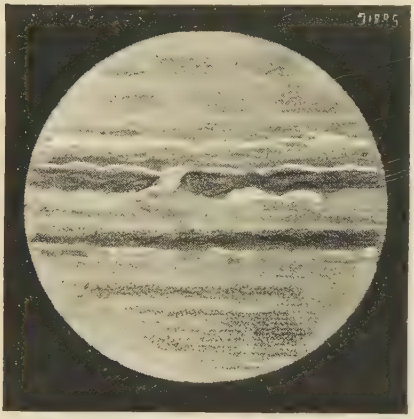


Fig. 16. J. Milton Offord, 12¼ in. Spec.
1898 June 21, 9 h. 10 m. Long. 322°.

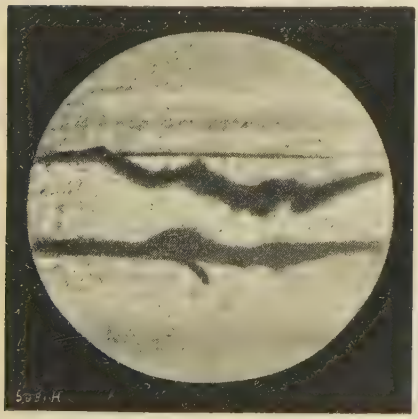


Fig. 17. E. J. Cope, 8½ in. Spec.
1898, January 2, 19 h. 30 m. Long. 343°.

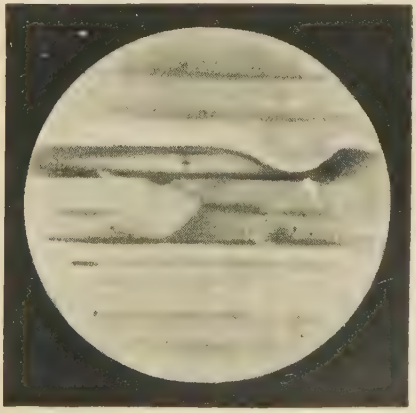


Fig. 18. T. E. R. Phillips, 9 in. Spec.
1898, March 29 10 h. 40 m. Long. 355°.

Memoirs

OF THE

British Astronomical Association

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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR.—HENRY CORDER.

REPORT OF THE SECTION, 1898.

Introductory.

This year's report will be found to contain a fairly full account of the Perseid Shower, which was well observed in England, and also some interesting observations of the Leonids made in India. Beyond this, not very much has been accomplished in watching the showers, some being hidden by cloud, and others, as the Andromedes and Taurids failing to put in an appearance. There is also a valuable table of heights of meteor paths, contributed by Mr. Denning, whom we are glad to welcome again as a Member of the Association. The Section numbers about 12 Members, but from some not much has been received during the year, and the Director would wish, while thanking those who have contributed, to encourage those who have not, and also Members of the Association in general, to send in any stray observations of bright meteors of which the paths have been pretty accurately noted.

Bridgwater,
January 31, 1899.

HENRY CORDER,
Director.

Monthly Record of Meteor Showers.

JANUARY.

The Quadrantid shower was unobserved in England this year, but Mr. Backhouse, who was then voyaging on the Arabian Sea, had clear skies, and watched at intervals on the nights of January 1 and 2. It appears from a table of his observations, that only four Quadrantids out of a total of eight meteors, were seen in 49 minutes on January 1, and seven Quadrantids out of nine meteors in 58 minutes on January 2. Four of these were seen in 16 minutes shortly before midnight, giving an hourly rate (corrected for altitude of radiant) of 29 per hour. Two bright meteors were seen.

FEBRUARY.

Mr. Besley mapped 16 meteors on the nights of February 20 and 22, a radiant in Bootes was probable. A few others were seen earlier in the month.

MARCH.

At the end of the month, Mr. Besley was again successful in mapping 14 meteors; a fairly strong radiant appeared in Draco, and another in Ursa.

APRIL.

The Lyrid shower was very poorly observed, and meteors were very scarce.

On April 19, Mr. Blakeley saw only six meteors in about $1\frac{1}{2}$ hours, one being equal to Jupiter. The radiant seemed to be at about $268^\circ + 36^\circ$, a good deal W. of the position mapped by Mr. Besley, and 10° N. of a position estimated by Mr. J. H. Bridger. So that it would seem that there were weak branch radiants active. Mr. Bridger only saw five meteors on this date between $9^h\ 45^m$ and $11^h\ 47^m$.

The night of April 20 seems to have been generally overcast. That of the 21st was finer, and Mr. Bridger saw six meteors in about $1^h\ 15^m$, and Mr. Besley saw the same number between $11^h\ 45^m$ and $13^h\ 30^m$.

On April 22, he tried again, watching from 12^h till $13^h\ 30^m$, and saw 14 meteors, of which eight were Lyrids. The radiant, rather diffused, was at about $273^\circ + 33^\circ$.

At Bridgwater, a watch was kept on the 17th, but only one meteor was seen in half-an-hour, and on the 22nd, only one in 40 minutes. Both these watches were, however, before midnight.

MAY AND JUNE.

Almost no meteors were seen in these months, and none of the May Aquarids.

JULY.

Mr. Besley began watching for Perseids by July 14, when three of these meteors were seen from a radiant at $12^\circ + 50^\circ$. Unfortunately observations were interrupted by a large conflagration in the neighbourhood, so that this is a rather uncertain position.

On July 20, four more were seen in $1\frac{1}{4}^h$, with a radiant at $21^\circ + 51^\circ$; one more only in an hour's watch on July 24; but on the 28th, six were seen in an hour, with a radiant at $32^\circ + 55^\circ$. These are an interesting addition to our knowledge of early radiants in this region, but may not all be connected with the August stream.

Mr. E. R. Blakeley says, that at Dewsbury, "the atmospheric "conditions were generally unfavourable, so that from July 26 "to August 19, only six nights were at all clear, and even then "haze prevailed round the horizon." July 27, only four meteors seen, one being probably a Perseid. At 11.30, a rather

remarkable meteor was seen, which began as 1st mag., decreased to 4th, and vanished altogether twice during its flight, reappearing some degrees further on. July 29, clear during latter part of watch, and 22 meteors mapped between 11^h and 13^h 10^m, of which six were Perseids with a good radiant at $31° + 54°$. The finest meteor was at 12^h 10^m, and was estimated as brighter than Jupiter, and moved slowly in the S.E. heavens, near the horizon. On July 30, in a short watch, only two meteors were seen.

AUGUST.

The Perseid shower was very generally observed on August 11, as this was a night of exceptional clearness, and in some parts of the country, a partial view was obtained on August 10, but the other nights were more or less overcast.

Several Members of the Section have sent special reports which will be given almost in extenso, and the radiants deduced from them will appear in the general list for the year.

August 8, a few observations made by Messrs. Backhouse and Besley, the latter counted seven meteors in 25 minutes. On August 9, Mr. J. H. Bridger had a clear sky at Farnborough, and counted 12 meteors in an hour (10.0 to 11.0), of which 10 were Perseids.

On August 10, he also watched from 10.10 till 11.0, mapping 24 meteors, of which 17 were Perseids, and then continued watching without mapping until 11.30, when 28 more meteors were seen, and the hourly rate of Perseids rose to 48.

At Yeovil, the Rev. T. E. R. Phillips watched from shortly before 10.0 until 13.0, and recorded 40 meteors, of which 27 were in the last hour. A brilliant meteor was recorded at 12.2, and five others are spoken of as "bright," one at 12.5 being green.

At Portland, the Rev. W. R. Waugh saw 18 meteors between 9.30 and 11.0, of which 15 were Perseids, and five were of 1st mag., with bright streaks, one of a pinkish hue.

At Bridgwater, a tolerably continuous watch was kept between 9.30 and 12.45, when it clouded over; and before that, moonlight and clouds began to interfere. In all, 96 meteors were counted, of which 88 were Perseids. The hourly number for all meteors rose to about 40, in spite of moonlight. It would not be of any value to give a detailed table of the watch, nor of the magnitudes, as both results would be vitiated by the moonlight, but there were 15 reckoned as 1st mag., and eight brighter than 1st, of which the finest were at 10.40 and 12.0, both flashing out at the end of their course, and the former one left a spot of light for some seconds where the flash took place.

At Bridport, Rev. S. J. Johnson watched from 10.13 till 11.13, and counted 11 meteors, of which 10 were Perseids, the finest (at 12^h $1\frac{1}{2}^m$), which was of a greenish colour, being equal to Jupiter.

August 11, Mr. Johnson again watched for an hour, and counted 18 meteors between about 10^h–11^h. One of them, at 10^h $1\frac{1}{2}^m$, was equal to Venus at her greatest brilliancy.

At Cardiff, Mr. George Carslake-Thompson watched from about 9^h 30^m until 14^h 0^m, and saw 77 meteors. The largest number were seen in the quarter hour preceding midnight, when 18 were counted, and 52 in the whole hour, 12.45 to 13.45. Most of the

meteors left phosphorescent streaks, and had bright heads, but those appearing near the radiant appeared to be almost all streak. The radiant was estimated to be at R.A. $2^h\,53^m + 55°\,40'$, but some came from nearer Cassiopeiæ. At Portland, Rev. W. R. Waugh noted eight meteors between 9.0 and 10.30, none occurring in the last half hour. (In this time, Mr. Thompson counted six, and the Director 11, after which the number more than doubled.)

At Dewsbury, Mr. Blakeley watched from $10^h\,20^m$ until $13^h\,40^m$ almost without intermission, and 52 meteors were seen, the Perseids being decidedly in the majority, with a radiant at 45 + 58 very diffuse.

The finest seen were at 10 $32\frac{1}{2}$ = Sirius; at 11 30 > γ; at 12 1 = Sirius; at 12 23 = Sirius; at 12 25 = Sirius, and at 13 2 equal Jupiter. That seen at 11^h 30 was a typical Perseid of the brightest class, expanding at the end of its path with a lightning-like flash; the broad streak was of an intense golden colour, and the meteor appeared slightly deflected at the end of its course. A meteor appeared at 11 11, which seemed like a small faint nebulous cloud, moving slowly.

Mr. Blakeley has seen four or five others at various times with this appearance, and the Director also can corroborate the observation during his experience. Conditions can hardly have been so good at Dewsbury, as only about 15 meteors an hour seem to have been recorded.

At Exeter, on this date, Mr. Besley watched from $9^h\,15^m$ until $12^h\,40^m$, and counted 75 meteors, the rate per hour rising from 15 to 30. Of these, six Perseids and 11 other meteors were of 1st mag., three Perseids were brighter than 1st mag., but less than Jupiter, whilst one at $12^h\,24^m$, and a non-Perseid at $10^h\,15^m$ were as bright as Venus. The latter and another "erratic" were of a bluish colour. Mr. Besley considers that only 40 out of the 75 were Perseids, a good many being from Cassiopeia. No doubt some other observers would hardly note this distinction, and the Director is sorry to add that he among them did not map very many, and has perhaps "lumped" them as Perseids. A pretty good watch, however, was kept at Bridgwater. In the first place, one observer watching from $9^h\,15^m$ until $13^h\,30^m$, counted 149 meteors, of which 135 were counted as Perseids. The best hour was from 10.30 until 11.30, when 50 were seen. After this they fell off, partly on account of slight moonlight, to 33 an hour by the end of the watch, of which only 26 were Perseids. The most beautiful meteor seen was an Aquarid, at 8.58, details of which are given elsewhere. The magnitudes were as follows:—

> 1st, 12; 1st, 30; 2nd, 61; 3rd, 75; 4th, 31; 5th, 9; coloured 12.

No bright flashing Perseids were seen, and only two equal to Sirius. There was a rich orange 1st mag. near the radiant, and an interesting 3rd mag. with long streak directed from Taurus. Perhaps the Director is over cautious in the matter of magnitudes, or only unlucky, but it is well to describe conscientiously what is seen, and interesting then to compare the results with those of others. Another point seemed to be of interest: during part of the time two other observers were assisting, so as to cover as much sky as possible, and there seemed to be a considerable difference in the number of meteors seen in different parts of the

sky. For instance, during an hour when Mr. Corder was watching the radiant and sky to E. of it, only 28 meteors were seen, whilst at the same time Miss M. L. Bayes, watching the western sky, counted 36, and Mr. T. B. Dilks had a similar experience watching in the direction of the Great Bear. So that it would seem that although the best estimate of the radiant is to be had by mapping the foreshortened meteors near it, yet more, with of course longer paths, are to be seen in other directions. These three observers also watched for an hour together. It should be stated that no part of the horizon was visible, and the view was a good deal shut in by trees and houses. Between 10.30 and 11.30 when the Director saw only 50 meteors, the three together counted 105, the best quarter-hour giving 29.

At Paignton, Mr. H. J. Townshend counted 50 meteors between 10.30 and 12 0, but some of the time was taken up in mapping. About six Cassiopeids were seen, and others thought to be from Hercules and Lyra. He considers that the hourly number between 10.30 and 11.30 was 60 meteors. The finest was seen at 9.19, and was estimated at twice the brightness of Venus, at the time when it broke out with a final flash. At 10.34 there was one as bright as Arcturus, with a red streak.

Mr. J. H. Bridger watched at Farnborough from 9.30 until 11.0 and 53 meteors were seen, the hourly rate when none were mapped between 10.30 and 11.0 being 60. Mr. Bridger was fortunate in observing the bright Aquarid mentioned above.

At Yeovil, Rev. T. E. R. Phillips, recorded 38 meteors between 9.40 and 11.56, and no doubt would have seen more but for time taken up by mapping.

At Aysgarth, Mr. J. E. Clark recorded 26 meteors in about an hour and a quarter, 10.0 to 11.15. Miss E. Brown also reports the shower as visible at Cirencester, and Mr. Backhouse saw a few at Seaton Carew. After this date very few were seen, and the weather was unfavourable.

SEPTEMBER.

As usual very few meteors were mapped in this month, which is not generally distinguished by strong showers, although those who diligently watch in the morning hours are often well repaid. Mr. Besley and Mr. Bridger both send notes of a few meteors, but not sufficient to deduce radiants from.

OCTOBER.

Mr. Besley recorded nearly 70 meteors in this month, chiefly on the 18th and 23rd.

On the 12th a few were seen, the chief radiant being in Aries.

The Orionids were active on the later dates, about 11 being put down to this shower, and six to that in Gemini, which is generally more or less contemporaneous. The Orion radiant was at 91° + 16°, about its usual position, indeed we always have found this one of the best defined and most stationary of all the chief meteor radiants, although the Geminids, which Mr. Besley places this year at 97° + 15°, and which are a much more diffuse system are often confounded with the true Orionids.

The following table gives the general results of the watches kept at Westminster for the Orionid and contemporary showers :—

1898.	Watches.				Number of Meteors recorded.						
					Radiants.						
	From.	To.	Length.	Free from Cloud.	Taurus, 64½° + 12½°.	Orion, 91° + 16°.	Gemini, 97° + 15°.	Gemini, 107° + 20°.	Telescopium, 115° + 37½.	Others.	Totals.
	h. m	h. m.	h. m.	h. m							
Oct. 18	12 30	14 15	1 45	1 15	2	7	3	—	1	12	25
„ 23	12 15	12 45	0 30	0 30	—	—	—	1	—	3	4
„ 24	12 45	15 15	2 30	2 25	1	4	3	2	2	19	31
Totals -	—	—	4 45	4 10	3	11	6	3	3	34	60

Mr. Besley adds :—"The most brilliant meteor appeared at "13h 24m on October 18, and travelled swiftly from 87°—1° to "105°—10°. Its brightness was nearly equal to that of Venus, "its colour was bluish-white, and its head well defined. This "was an Arietid.

"Meteors of the 1st mag. were registered on the 18th at 12.57, "at 13h 12m (slow, orange), at 13h 52m (Orionid, bluish-white), "and on the 24th at 14h 47½m. The meteors from Taurus were "swift, the Orionids and Geminids also swift, and for the most "part left streaks."

NOVEMBER.

This was a month of disappointment and delusion, for clouds almost entirely hid the Leonids, and where clear very few were seen, and of the expected Andromedes none whatever appeared.

The Director has had many reports of the Leonids sent to him, for all which he hereby tenders his thanks, and will proceed to give a short summary of the more important ones, the rest being almost entirely a record of failure.

It may first be mentioned that the best view of the shower was evidently obtained in America, but even there it never reached the level of a great display, and elsewhere the Leonids hardly outnumbered the uncomformable meteors.

The most interesting record of the event has been sent by Mr. H. G. Tomkins, of Madras, who trained a number of educated native Indians to watch together, and although the resulting radiants are, perhaps, not very trustworthy, yet the details of the strength of the shower are valuable. Mr. Tomkins says :—"As I "have a house-top to work on, and a clear horizon all round, I "got together the party of 25 observers, chiefly from my office "here. They are educated men and soon took to it. They were "trained, as far as possible, by the aid of artificial showers made

"with a magic-lantern, and also by studying the sky with their "maps for several nights beforehand. Some of them had some "knowledge of astronomy, and one had been trained in the "observatory.

"Seven cameras were set up, one a 4-in. lens, and one a magic-"lantern lens. Both these gave clear star trails, but unfortunately "caught no meteor. Another with a small wide-angle lens shows "the trail of Regulus, and a long path of a meteor very faintly, "showing a somewhat broken line, as if the light of the meteor "varied many times during its flight.

"The sky was under observation all the night, and every meteor "was counted. The parties worked in very good accord. The "counters were at a separate table, and the duration of flight of "the meteors was estimated by the aid of a pendulum, a man "keeping time on a box with a stick, as a metronome could not "be obtained; time was called every five minutes through the "three nights."

As far as possible other meteors than Leonids were excluded; during some of the watches they more than equalled the number of Leonids, but on the principal nights of the shower were of comparative rarity.

From November 7 to November 12, two separate observers were keeping watch between the hours of $13^h\ 30^m$ and $15^h\ 30^m$, and taking the most successful one, the results were of Leonids, in two hours, November 7th, 3; 8th, cloudy; 9th, 6; 10th, 21; 11th, 28; 12th, 28. On November 13 the combined watch began at 10.45, and 23 Leonids were seen in the first two hours, when it clouded over for three hours. At $15^h\ 45^m$ watching was resumed, and about 30 meteors were seen in an hour. On November 14 clouds obscured the sky until $13^h\ 25^m$, and only four Leonids appeared before 14^h. The numbers then run; to 15^h, 48 Leonids; to 16^h, 75; to 17^h, 79; to $17^h\ 20^m$, 42, when daylight became too strong.

The shower, however, evidently increased steadily, for in five minutes after $17^h\ 10^m$, 14 Leonids were seen. On November 15 it was clear all night, and even before midnight Leonids had begun to appear.

Beginning at $10^h\ 30^m$, the hourly numbers run,—15, 29, 41, 60, 81, 142, 74. The last number, however, does not represent a complete hour, as daylight came on about $17^h\ 20^m$. After this the combined watch was discontinued, but on the 16th, 38 Leonids were seen by one observer in two hours; on the 17th, 18 were seen; on the 18th, 15, with 24 from other radiants; on the 19th, 17 Leonids, and 12 others; on November 20th, 16 Leonids, and 14 other meteors. From these figures it appears that the maximum of the shower, as seen in India, was at 16^h on November 15, but that on the 14th also the earth was already deeply immersed in the meteor stream. It may be said that at the time of writing Mr. Tomkins was not a member of the British Astronomical Association, but was desirous of joining the Association, and the thanks of the Meteor Section are all the more due to him for his kindness in sending his most interesting results,

and for the careful way in which he carried out his plans, which most fortunately were but little interfered with by the weather. Mr. Tomkins also sends maps of meteor tracks made by an Indian gentleman, near Trichinopoly, who observed a large number of Leonids and other meteors. The radiants do not come out very clearly, and the Director again wishes to impress on observers the absolute necessity of watching with a rod in the hand, to hold up immediately along the line of flight, and also in mapping, at once to carry back the line to some distant star, if possible near to or beyond the supposed radiant. Only one brilliant meteor appeared, which unfortunately ended with a bright flash behind a cloud.

On November 12 a watch was kept at Bridgwater, from $14^h\ 35^m$, until daybreak at about $17^h\ 10^m$, and 27 meteors were seen, but only about six were Leonids. The finest meteors came from the direction of Taurus and apparently belonged to at least two radiants, but not more than one or two could have been of the usual Taurid shower.

Mr. Backhouse made a number of short watches, but did not see many meteors. His chief watch was in the twilight of November 13, when one meteor was thought to be a Leonid. The next two mornings were overcast. Mr. W. J. Hall was watching on the same morning, and also found meteors very scarce; only two meteors seen in about an hour, and neither of them a Leonid.

Mr. Pope, at Dingwall, had the morning of the 16th clear, and saw about a dozen meteors, of which about eight were Leonids. These were seen between 3^h and 4^h a.m.

Mr. J. H. Bridger, at Farnham, on November 13, watched from $14^h\ 5^m$ till $17^h\ 20^m$ and saw 11 meteors, of which seven were Leonids with a radiant of $150° + 22°$. One meteor as bright as Sirius, seemed to explode at $15^h\ 26^m$.

Mr. Besley was disappointed altogether, as were also Mr. Blakeley and Mr. Townshend. Mr. H. Pain, at Cambridge, sends notes referring to each night, chiefly describing the varying density of the clouds until November 14, at $16^h\ 35^m$, a bright flash was seen. After this, although hazy clouds almost entirely hid the stars, eight meteors were seen before $17^h\ 30^m$, chiefly in the S., as the observations were made from a window. Mr. G. B. Longstaff and others, at Wimbledon, succeeded in seeing two rather bright meteors on November 14, that at 10.20 being brighter than Mars, and travelling about 120°.

On November 13, Mr. W. M. Worssell, observing from the Esplanade, Bognor, saw a fair number of meteors between 12.30 and $17^h\ 45^m$ in a clear sky, but the rest of the reports received are of total failure.

The Andromedes never came at all, although a great shower was expected. It was, indeed, moonlight at the time, but on many evenings during the week stars were fairly bright, but no one seems to have recorded a single meteor, and up to the time of writing nothing has been heard of any foreign observation of the shower. Although the weather accounts for most of the failures

in November, yet there were times when the sky was clear, and it should therefore be noted that, with one or two possible exceptions, no Taurids were recorded during the month, and it can hardly be doubted but that the shower was very weak this year.

DECEMBER.

The Geminid epoch was almost as overcast as the Leonid, but Mr. Besley succeeded in making a good observation on December 9, and again on December 12. There appeared to be three radiants in Gemini, the chief one at 115° + 32°, another at 104° + 31°, and the third at 108½° + 28°. This only produced three meteors, but from their different character it may be considered that they belonged to the shower of long streak-leaving meteors seen in former years, but lost for some long time. Only about 10 meteors per hour were recorded on the 12th, and a less number on the 9th. One Geminid was as bright as Jupiter. There appeared to be radiants also in Monoceros, Auriga, and Cancer. Mr. T. H. Astbury sends a list of meteors, one of them, a 1st mag., being stationary 1° N.W. of Castor at 8.29 on December 9, and, no doubt, fixing the radiant of the Geminids pretty nearly. Mr. J. H. Bridger watched from 9 till 11 on December 9, and saw 10 meteors, of which only one or two could have been Geminids. The strongest radiant seemed to be in Ursa Major at 122° + 41°. Mr. T. W. Backhouse made the most complete series of observations at the Geminid epoch, but did not record any until December 7, when one was seen. On December 11, in 83^{m} before midnight, nine meteors were seen, of which six were Geminids; but the sky was covered with thin cloud. On December 12, in 125^{m} between 7 o'clock and 13^{h} 22^{m}, 25 meteors were seen, 19 being Geminids. The hourly rate for all meteors rose to about 19 after midnight. Two more Geminids were seen on the 13th, but none on the 14th. One meteor at 12.29 on December 12 was equal to Venus, and brilliantly coloured.

At Bridgwater, watches of short duration were made on December 7 (no meteors), December 12 (one Geminid), December 15 (four meteors, of which one was a Geminid). On December 19, Mr. Besley recorded 20 more meteors, with radiants in Leo, Ursa, and Draco. The last-named seemed a very active shower, with a radiant at 197½° + 69°, seven meteors, of which two were brighter than 1st mag.

Radiants of Meteor Showers, 1898.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.		° °			
790	Feb. 20–22	Bootes	215 + 33	4	Quick	W. E. B.
791	Mar. 29–31	Ursa Major	178 + 57½	4	Quick	W. E. B.
792	„ „	Draco	245 + 55	6	Swift	W. E. B.
793	Apr. 19	Lyrids	268 + 36	4	Swift	E. R. B.
794	„ 19–21	„	268 + 25	5	Swift	J. H. B.
795	„ 21–22	„	273½ + 32½	12	Swift	W. E. B.
796	July 14	Perseids	12 + 50	3	Swift	W. E. B.
797	„ 20	„	21 + 51	3	Swift	W. E. B.
798	„ 28	„	32 + 55	4	Swift	W. E. B.
799	„ 29	„	31 + 54	5	Swift	E. R. B.
800	Aug. 8	„	42 + 57	3	Swift	W. E. B.
801	„ 9	„	42 + 55½	10	Swift	J. H. B.
802	„ 10	„	43 + 55½	16	Swift	J. H. B.
803	„ 10	„	43 + 59	11	Swift	H. C.
804	„ 10	„	45 + 55	—	Swift	T. E. R. P.
805	„ 10	„	43 + 53	—	Swift	J. H. T.
806	„ 11	„	45 + 58	40	Swift	W. E. B.
807	„ 11	„	45 + 56	13	Swift	J. H. B.
808	„ 11	„	49 + 58	13	Swift	H. C.
809	„ 11	„	46 + 58	—	Swift	T. E. R. P.
810	„ 11	„	46 + 56	29	Swift	J. H. T.
811	„ 11	„	45 + 58	30	Swift	E. R. B.
812	July 29	Polarids	5 + 88	6	Quick	E. R. B.
813	Aug. 9	Cepheids	323 + 65	3	Quick	J. H. B.
814	„ 11	Cassiopeids	2 + 50	11	Swift	W. E. B.
815	Aug.	Camelids	67 + 55	4	Swift	J. H. B.
816	„ 11	„	70 + 65	4	Swift	T. E. R. P.
817	„ 11	θ Aquarii	328 + 6	7	Slowish	E. R. B.
818	„ 11	δ Equulei	317 + 10	6	Quick	E. R. B.
819	„ 11	Piscids	348 + 3	5	Slowish	J. E. C.
820	„ 11	„	350 + 5	2	Slowish	H. C.
821	„ 17	Pegasids	345 + 15	4	Quick	E. R. B.
822	„ 17	Honorids	347 + 51	4	Quick	E. R. B.
823	Sept. 9	Perseids	47 + 39	4	Swift	W. E. B.
824	Oct. 12	Arietids	43½ + 16½	4	Slow	W. E. B.
825	„ 18–24	Muscids	43 + 22	3	Slow	W. E. B.
826	„ „	Taurus	64½ + 12½	4	Slow	W. E. B.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.		° °			
827	Oct. 18–24	Orionids	91 + 16	7	Swift	W. E. B.
828	„ „	γ Geminids	97 + 15	3	Swift	W. E. B.
829	„ „	δ Geminids	107 + 20	3	Swift	W. E. B.
830	„ „	Telescopium	115 + 37½	5	Swift	W. E. B.
831	Nov. 14	Leonids	153 + 20	—	Swift	Indian.
832	„ 14	„	148 + 21	—	Swift	Indian.
833	„ 15	„	148 + 24	—	Swift	Indian.
834	„ 15	„	148 + 24	—	Swift	Indian.
835	„ 16	„	154 + 20	5	Swift	J.T. Pope.
836	„ 12	„	144 + 27	4	Swift	H. C.
837	„ 13	„	150 + 22	7	Swift	J. H. B.
838	„ 13	Ursa Major	151 + 66	4	Quick	H. C.
839	„ 13	ζ Tauri	83 + 24	5	Slow	H. C.
840	„ 13	o Tauri	52 + 5	5	Slow	H. C.
841	„ 13	β Cancri	123 + 14	2	Quick	H. C.
842	„ 14	„	122 + 9	—	Quick	Indian.
843	Dec. 12	Cancer	130 + 20	5	Quick	W. E. B.
844	„ 12	Auriga	71½ + 47	3	Swift	W. E. B.
845	„ 9–12	Monoceros	99½ − 5½	4	Swift	W. E. B.
846	„ „	Gemini	108½ + 28	3	Swift	W. E. B.
847	„ „	Geminids	104 + 31	7	Quick	W. E. B.
848	„ „	„	115 + 32	11	Quick	W. E. B.
849	„ 9	Ursa	122 + 41	4	Swift	J. H. B.
850	„ 19	Ursa	174½ + 58½	4	Swift	W. E. B.
851	„ 19	Leo	151½ + 26½	3	Swift	W. E. B.
852	„ 19	Draco	197½ + 69	7	Swift	W. E. B.

Doubly observed Meteors, 1898.

FIREBALL OF JANUARY 21d 5h 32m.

This was, perhaps, the most interesting meteor of the year, and a great many accounts were received, either by letter or newspaper cuttings. Mr. Denning used 33 in his calculation of its path, so it was evidently very generally observed in the south of England at any rate. The real path was such a long one, and was prolonged so far over the English Channel that it is difficult to say where the real end-point was, for it is evident that many observers only saw the earlier part of its flight, not many noticing the explosion which occurred towards the end. The height at first appearance was 82 miles over Croydon, after which it traversed the very long path of 235 miles at a rate of 34 miles

per second, and ended over the Channel at a height of 25 miles. The radiant was at 130° + 30° in Cancer. Mr. Denning compares this with the path of a fireball of January 19, 1877, at $6^h\ 27^m$, the length of path, velocity and radiant agreeing almost exactly.

In colour the meteor is very variously described. Perhaps the following description shows the sequence of the changes:—At commencement reddish, then yellow or golden, turning to electric blue, and then green, when it burst into a number of yellow fragments. It seems to have been accompanied by a train. Of course, the apparent size varied very much at different distances. At Catford it appeared of the size of Venus, but from Torquay, much nearer the end of the path, it appeared of the "perfect "shape and size of the full moon, when it suddenly changed to "the shape of a pear (stalk foremost), then burst. A stream of "light gushed out, preceded by a row of stars of vivid coloured "brilliancy, and the whole together at the same speed vanished "into space."

GREAT FIREBALL OF JANUARY 26. (*Communicated by Mr. Walter F. Gale*).

A fireball of unusual magnificence appeared at $10^h\ 6^m$ on the night of January 26. At this time I was standing with others on the bridge at the entrance to Lake Macquarie looking northward up the channel, and watching the innumerable fish faintly outlined in the phosphorescent water. Suddenly the whole scene was brilliantly illuminated, two small vessels and the trees a quarter of a mile distant showing out clearly. The fish simultaneously darted in all directions, many hundreds of mullet, taylor, and perch making clean breaches from the water. Several members of the party exclaimed, "lightning," and such was my own first impression. The moon was absent from the sky, and I knew it was absolutely cloudless to the horizon, so instinctively turned to the south-east.

Immediately above δ Centauri, moving northwards, was a mass of intensely bright green light, estimated at 18′ × 12′, with several small detached fragments of a ruddy colour. The path it had traversed was still glowing, and extended back to the Cross. The motion of the meteor was slow, carrying it over ζ Hydræ to a point preceding δ Crateris. I fixed the beginning and end points of the track seen by me as R.A. $11^h\ 58^m$ — 50° and R.A. $11^h\ 5^m$ — 14°, and the period occupied in traversing it three seconds. No detonation was heard. A Mr. Drew, who saw the first outburst of the fireball, pointed out to me at the time the star ι Hydri as near the origin of its visibility. He was certain the point was between the Magellanic clouds, and as nearly as I could fix it at R.A. $3^h\ 20^m$ — 78°. It rapidly blazed out, and seemed to him as large as the moon, but much more brilliant.

I have failed to obtain intelligible tracks from those who saw the meteor from Newcastle, but trust an observer to the south of our station will furnish useful particulars.

METEOR OF FEBRUARY 20, $8^h\ 54^m$.

A large number of observations of this meteor came to hand, some of them from our own Members. Mr. Besley saw it, and

rated it as brighter than Venus, and of a bluish-white colour, moving swiftly. Unfortunately there seems to have been more confusion about this meteor than is usually the case, and Mr. Denning says that he spent several whole days trying to unravel the mystery. It is always possible that more than one meteor may have been seen, and on this occasion Mr. Besley's path does not agree with most of the others, and Mr. Ryle, who writes from Brighton gives the date as Monday, February 21. In other respects it agrees with the other observations. His meteor somewhat exceeded Venus in brilliancy, and was of a yellowish white. The path ultimately decided on by Mr. Denning was 95 miles in length, performed at the rate of 24 miles per second, from a height of 61 miles to one of 24 miles over the English Channel. The radiant was near β Leonis.

METEOR OF APRIL 5, $10^h\ 15^m$.

The following account was furnished by the Rev. T. E. R. Phillips:—" I was fortunate enough to see a splendid meteor on " April 5 at $10^h\ 15^m$. It was simply magnificent, in spite of the " moonlight, and travelled visibly over a path exceeding 100° of " longitude. The moonlight, and consequent paucity of bright " stars, made it somewhat difficult to determine its track with " accuracy, but I think the following particulars are not far off " the mark. Time occupied in traversing its apparent path, " 12 to 15 seconds. Colour, golden yellow or orange. Magnitude " about equal to Venus. Estimated track from 154° + 17° to " 260° + 22°. The meteor left a train of sparks behind it. " I should say that I probably missed its first appearance, but " it arrested my attention when observing Jupiter, by the brilliant " light it caused in the sky. I also lost its final disappearance, as " it dropped behind some houses, and so was lost to view, though " fast fading at the time." Mr. Denning received other observations of this fine object, and it will be seen, by referring to his table, that it was a Monocerotid, with a radiant at 121°—1°, and during a visible path of 162 miles, traversed at a speed of about 11 miles per second (the slowest of any in the list, it may be noted), it fell from a height of 89 miles over a point 25 miles S.E. of Dartmouth to a height of 25 miles over a point five miles N.E. of Bisley.

AQUARID METEOR OF AUGUST 11, $8^h\ 58^m$.

This beautiful meteor was seen by many in the twilight of August 11, just as the Perseids were beginning to appear. It belonged, however, to the well-known shower of Aquarids, with a radiant at 339°—10°. It was estimated as equal to Jupiter or Venus in brilliance, and had a long, almost horizontal path, as seen by most English observers, as it travelled from a height of 66 miles over the River Seine to a height of 41 miles over Okehampton, a distance of 196 miles at a somewhat slow rate. Reports were received from Mr. W. J. Stanton, of Stroud, who noted that the train was bright at the latter part of its course, and that it lasted several seconds; from Mr. E. W. Johnson, of Croydon, who says that it travelled from S.E. to S.W. passing

just below Saturn; and from Mr. F. W. Levander, in London, who noticed, as others did, that a number of sparks were given off near the end, but did not consider that any streak was left. It was well seen at Bridgwater, and as this was nearer the end point, the "sparks" appeared more brilliant and took the form of small balls of fire given off one after another, until towards extinction, there were, perhaps, four, inclusive of the head, forming a train of white bodies followed by a reddish train or streak, which extended for a distance of about 4° behind the meteor. Mr. T. H. Astbury gives the duration as four seconds, and states that there were five or six fragments dying away one after another.

METEOR OF AUGUST 19, 10^h (local time).

A fine meteor, seen by Rev. T. H. Foulkes from S.S. "Malacca," off Algiers. The meteor was seen on the confines of Aries and Taurus, and was of all colours, chiefly scarlet and orange, not very swift, but with a "powerful" motion. Train short, and general shape like an Indian club. The moment it vanished, close to the horizon a double flash of sheet lightning appeared exactly under the vanishing point of the meteor. As no other flashes were seen during the evening, Mr. Foulkes conjectures that they may have been connected with the meteor, which seems highly probable.

METEOR OF OCTOBER 4, 6.25 (Calcutta time, 5^h 53^m E.).

Mr. J. W. Meares reports this meteor from his own observation, and also that of others who saw it, and it may be interesting to give the accounts pretty much *in extenso*. Mr. Meares says that "daylight prevented the path being noted properly, but it is "roughly, as follows. Started in R.A., 18^h 20^m, Dec. — 5°, "ended by disappearing behind a house at an altitude about "5° lower. Path nearly 60° in about $3\frac{1}{2}$ seconds, very slow "indeed. Colour dull orange, about 1st mag. at first, increasing "until it had a sensible diameter of nearly $\frac{1}{4}°$, and of a brilliant "white, casting a strong shadow even in the daylight. A train "of sparks was visible some few seconds after disappearance." Mr. H. J. Bell saw it at Chandbali, Orissa (some 160 miles from Mr. Meares' station), and says it seemed to pass almost directly overhead and disappear in the E. A lady in Dacca estimated the time at five or six seconds, and it was travelling S.E. Mr. W. S. Adie, at Berhampore, near Moorshedabad, writes, that it began a little E. of S., and finished a little S. of S.E., travelling horizontally at an altitude of 10°. Among other accounts, Rev. E. G. Roberts, Masulipatam, about 620 miles S.W. from Calcutta, reports that it was seen there, but from its greater distance did not appear brighter than Venus on a dark sky, and was of a vivid blue. These are chiefly of interest to show the long distances over which large meteors are visible, for the details are hardly sufficient to decide on a path for it.

REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1898. *Contributed by* W. F. DENNING.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Jan. 21	5 32	$\frac{1}{2}$=)	82	25	235	34	Croydon, Surrey	English Channel	133 + 30	*Cancrid*	33 observers.
Feb. 20	8 54	>♀	61	27	95	24	33 miles S. of Beachy Head.	13 miles S.E. of St. Albans Head.	176 + 12	*β Leonid*	18 observers.
April 5	10 15	2×♀	89	25	162	11	25 miles S.E. of Dartmouth.	5 miles N.E. of Bisley.	121 − 1	*Monoceroti.*	5 observers.
,, 16	9 46	3—1½	72	55	52	Slowish	8 miles E. of Nottingham.	7 miles E. of Glossop	212 − 11	*Librid*	A. S. H.; A. K.
,, 16	10 48	Sirius—1½	60	48	91	24	Halstead, Essex	North Sea	189 − 31	*β Hydrid*	A. S. H.; A. K.
,, 17	9 40	2½—1	85	71	81	41	Stafford	Bridgnorth	261 + 14	*αOphiuchid*	A. S. H.; A. K.
,, 17	9 55	4—3	57	55	24	Slow	Chesham	Bicester	236 − 13	*ψ Scorpid*	A. S. H.; A. K.
,, 17	10 28	5—3	72	70	34	23	Malmesbury	Evesham	176 − 35	*β Hydrid*	A. S. H.; W. F. D.
,, 17	11 12	3—2¾	67	44	24	Slow	Stroud	Gloucester	195 + 40	*α Canes Venaticid.*	A. K.; W. F. D.
,, 17	11 28	2	65	61	25	36	Amesbury	Burton	291 + 13	*ε Sagittid*	A. S. H.; A. K.; W. F. D.
,, 18	11 55	2—1½	65	58	19	32	Pontypool	Merthyr	274 + 11	—	A. S. H.; W. F. D.
,, 22	10 30	5—4	72	52	26	Slow	Alcester	Malvern	252 + 49	*β Draconid*	A. K.; W. F. D.
July 16	11 42	2>1	79	37	46	21	Thrapston	Bedford	273 + 76	*ψ Draconid*	A. K.; W. F. D.
,, 26	9 10	½=)	73	27	191	Slow	25 miles W. of Dieppe.	March, Cambs.	269 − 23	*Sagittarid*	Dennett, Grover, &c.
,, 30	10 43	1—2	81	47	57	36	Northampton	Burford	23 + 53	*Perseid*	A. S. H.; W. F. D.
,, 30	10 53	4—3½	61	52	20	14	Witney	Shipston	311 − 10	*μ Aquarid*	A. S. H.; W. F. D.
,, 30	11 10	3½—3	56	50	28	20	Chipping Norton	Alcester	340 − 18	*δ Aquarid*	A. S. H.; W. F. D.
,, 30	11 35½	3—1	66	52	63	45	Littleport, Cambs.	Blakesley	42 + 23	*ε Arietid*	A. S. H.; W. F. D.
Aug. 11	8 58	2—♀	66	41	196	Slow	River Seine, France	Okehampton	339 − 10	*δ Aquarid*	H. C.; W. F. D., &c.
,, 11	10 15½	2—♀	92	68	45	Swift	Aberdovey	Cardigan	44 + 56	*Perseid*	Five observers.

REAL PATHS OF FIREBALLS AND SHOOTING STARS, &c., 1898—*continued.*

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° $\delta_\circ$		
Aug. 11	10 26½	2½—2	86	61	45	58	Shiffnal - -	Leominster - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	10 46	2½—2½	79	65	23	46	12 miles W. of Brecon.	Swansea - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	11 11½	1>1	85	49	57	Swift	Redditch - -	Monmouth - -	44 + 56	*Perseid*	W. E. B.; W. F. D.
„ 11	11 52	2—1½	55	49	53	27	Oakham - -	Chesterfield - -	4 − 20	*β Cetid*	A. K.; W. F. D.
„ 11	11 57	3—2	56	39	25	36	Winchester - -	Fareham - -	57 + 73	*Camelid*	A. S. H.; A. K.
„ 11	12 6½	1	86	46	59	Swift	Kingston - -	Selborne - -	46 + 58	*Perseid*	S. J. J.; T. E. R. P.
„ 11	12 16½	1½—1	74	50	33	Swift	Watlington - -	Hermitage - -	50 + 63	*Perseid*	A. S. H.; W. F. D.
„ 11	12 20	1½—1	64	48	24	37	Cirencester - -	Chipping Sodbury -	54 + 56	*Perseid*	A. S. H.; W. F. D.
„ 11	12 24½	>1—2½	78	52	36	38	Alton, Hants -	Southampton -	49 + 59	*Perseid*	A. S. H.; W. F. D.
„ 11	12 40	2½—1	85	60	32	31	Chichester - -	Ryde, Isle of Wight	43 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	12 46½	3—2½	75	59	21	Swift	Oxford - -	Abingdon - -	59 + 63	*Camelid*	A. S. H.; W. F. D.
„ 17	11 43	2—1	71	55	32	43	10 miles N. of Slough	Basingstoke -	72 + 52½	*Aurigid*	A. S. H.; W. F. D.
„ 21	9 16	1½× ♀	60	29	95	19	15 miles S.E. of Cressy, France.	36 miles S. of Brighton.	5 + 13	*γ Pegasid*	A. S. H.; A. R. Schulz.
Sept. 15	8 17	1—2½	69	61	58	39	Thame, Oxon. -	Salisbury - -	65 + 35	*ε Perseid*	Col. Herschel; W. F. D.
„ 16	10 55½	>2—1	82	55	39	Swift	Devizes - -	Stroud - -	351 + 7	*θ Piscid*	A. K.; W. F. D.
„ 17	11 40½	1—2½	95	64	93	—	Strait of Dover -	Woolwich - -	57 + 7	*ϵ Taurid*	A. S. H.; A. K.
„ 17	11 52	4½—1	64	52	19	19	Northampton -	Market Harboro' -	343 ± 0	*β Piscid*	A. S. H.; A. K.
„ 18	8 54	>2½	69	46	104	Swift	Minehead - -	20 miles S.E. of Falmouth.	84 + 41	*β Aurigid*	T. E. R. P. and others.
„ 22	9 13	3—1	107	82	34	V. slow	Harleston - -	10 miles S.E. of Lowestoft.	254 + 39	*π Herculid*	A. K.; W. F. D.

Abbreviations:—A. S. H., A. S. Herschell, Slough; A. K., A. King, Leicester; W. F. D., W. F. Denning, Bristol.

BRIGHT METEORS OBSERVED DURING 1897.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Jan. 1 -	12 14 34	Sirius	Beautiful. Appeared at l^2 Virginis, passed 15 Sextantis. Disappeared near ι Hydræ, moderately quick. Duration, 2·9 secs. Faded gradually. Bright streak or train along about 10° of its course at a time.—T. W. B., Arabian Sea.
„ 2 -	11 41 16	Venus	Very beautiful, passed, or directed from $\frac{3}{4}$ (p q) Velæ, towards $\frac{3}{4}$ (δ o) Arg. Disappeared about 4° before that; course about 15°. Quick. When brightest, was bright yellowish green, which was shortly before disappearance. Bright greenish streak.—T. W. B., Arabian Sea.
„ 21 -	5 31 0	$\frac{1}{2}$ ☾	(*See* special account.)
„ 26 -	10 6 0	= ☾	(*See* special account.)
Feb. 20 -	8 54 0	> ♀	From 111° + 5° to 97° − 17°. Bluish white, swift.—W. E. B. (*See* special account.)
„ 21 -	9 10 0	> ♀	From 10h. 18m. + 17°·5 to 7h. 18m. + 35°. Duration 3 or 4 secs. Bluish white. Train of 4°.—EVAN REES, Stockton.
Mar. 6 -	10 0 0	♃	Passed slowly from 8h. 20m. + 29° to 7h. 42m. + 35°. White, with short train.—EVAN REES, Stockton.
„ 14 -	12 4 0	> 1	From 86° + 33½° to 76° + 32° very slow.
Apr. 5 -	10 15 0	♀	(*See* special account.)
„ 19 -	10 50 0	♃	From 252° + 23° to 242° + 19°. Slow. Colour, bluish white.—E. R. B.
July 14 -	8 16 0	> ♀	From near ϵ Delphini towards lower part of Pegasus, passing out of sight behind building. 10° of path seen. Very slow. Colour yellowish white, no train. —R. J. RYLE, M.D., Brighton.
„ 29 -	12 10 0	> ♃	From 346° + 5° to 333° − 6°. Slow. Orange yellow. Near limit of vision.—E. R. B.
„ 31 -	10 21 0	♃	About 30° S.E. of Moon, directed from Altair. Red. Short train.—H. J. T., Paignton.
„ 30 -	10 43 0	♃	From 15° + 54° to 4° + 54½°. Very slow. Streak, near its radiant, an early Perseid.—W. F. D.
Aug. 3 -	9 58 0	♃	From 15° + 43° to 25° + 22°. Duration 1 sec. Red streak.—H. J. T., Paignton.
„ 3 -	10 38 0	Capella	From 51° + 51° to 57° + 48°. Duration 1 sec. Blue streak.—H. J. T.
„ 6 -	10 30 0	♃	From 307° + 13° to 299° − 1°. Burst out as a flash of light. Duration 1 sec.—H. J. T.
„ 8 -	9 41 0	> 1	From 355° + 46° to 334° + 30°. Swift. Streak.—W. E. B., Exeter.
„ 9 -	9 37 0	♃	Directed from δ Ursæ Majoris, towards ½° s.p. η Bootis, disappeared 1° before that. Course seen 6°. Very quick, 3 secs. Streak or train.—T. W. B.
„ 10 -	10 36 0	Sirius	From 328° + 60° to 302° + 46°. Swift, streak.—H. C.
„ 10 -	10 40 0	♃	From 333° + 35° to 315° + 10°. Long streak, flash at end, leaving spot for some seconds.—H. C.
„ 10 -	10 41 0	Bright	From 325° + 67° to 279½° + 42°.—T. E. R. P.
„ 10 -	10 43 0	> 1	From 246° + 62° to 242° + 46°. Quick, streak.—H. C.
„ 10 -	10 50 0	♃	Directed from α (γ η) Persei towards α Andromedæ, disappeared about Dec. + 45°. Course, 6° or 7°. Moderate speed.—T. W. B.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 10 -	10 50 2	Sirius	Directed from α Pegasi, disappeared about $\frac{2}{3}$ (γ Pegasi, α Andromedæ). Course 10°. Moderate.—T. W. B.
„ 10 -	10 51 0	>1	From 75° + 63° to 80° + 63°. Yellow. Swift, streak.—H. C.
„ 10 -	11 25 0?	>1	From 360° + 18° to 349° + 2°. Orange. Streak.—H. C.
„ 10 -	11 59 0	Bright	From 343° + 28° to 330° + 83°.—T. E. R. P.
„ 10 -	12 0 0	4	From 30° + 69° to 20° + 73°. Bright flash and streak.—H. C.
„ 10 -	12 1 30	4	From near γ Cephei to a point below Polaris. Greenish.—S. J. J.
„ 10 -	12 2 0	4?	From 35½° + 65° to 215° + 77°. Large, bright.—T. E. R. P.
„ 10 -	12 5 0	Bright	From 187½° + 54° to 177½° + 46°. Green.—T. E. R. P.
„ 10 -	12 5 0	>1	From 247° + 43° to 247° + 30°. Fine. Orange, streak.—H. C.
„ 10 -	12 6 0	1	From a point 1° N. of β Persei to 8° towards S.W.—S. J. J.
„ 10 -	12 6 0	—	From 11¼° + 28° to 354½° + 12°.—T. E. R. P.
„ 10 -	12 7 0	—	From 38½° + 47° to 32½° + 32°.—T. E. R. P.
„ 10 -	12 8 0?	>1	From 290° + 52° to 275° + 38°. Orange. Streak.—H. C.
„ 10 -	12 24 0	Bright	From 60° + 60½° to 72° + 62°.—T. E. R. P.
„ 10 -	12 52 0	Bright	From 334½° + 70° to 265° + 55½°.—T. E. R. P.
„ 11 -	8 58 0	>♀	(*See* special account.)
„ 11 -	9 18 0	>1	From 353° + 38° to 343° + 27°. Red. Swift. Streak.—H. C.
„ 11 -	9 19 0	2×♀	From 95° + 70° to 157° + 59°. Very fine. Blue flash and streak.—H. J. T., Paignton.
„ 11 -	10 1 30	♀	From 5° E. of γ Ursæ Majoris passed over χ and disappeared 1° further.—S. J. J.
„ 11 -	10 14 0	4	Directed from near ϕ^2 Andromedæ and γ Persei. Dispeared near β Andromedæ. Slowish from nearness to radiant.—T. W. B., Seaton Carew.
„ 11 -	10 15 0	♀	From 140° + 72½° to 165° + 64°. Swift, streak.—W. E. B., Exeter.
„ 11 -	10 16 0	4	From 200° + 61½° to 206° + 44½°. Rapid with streak and flash. Perseid.—W. F. D.
„ 11 -	10 17 0	Very bright.	From 160° + 71° to 189½° + 45½°.—T. E. R. P.
„ 11 -	10 17 0	Sirius	From 165° + 73° to 184° + 54°. Yellow. Swift. Streak.—H. C.
„ 11 -	10 17 15	1	Commenced ⅛° above α Ursa Majoris, vanishing at γ.—S. J. J.
„ 11 -	10 32 30	Sirius	From 342° + 40° to 345° + 13°. Swift. White, not α Perseid.—E. R. B.
„ 11 -	10 34 0	Arcturus	From 98° + 56° to 117°+51°. Wavy path. Red streak.—H. J. T.
„ 11 -	10 34 15	1	From ψ Ursæ, and travelled 12° diagonally towards W. horizon.—S. J. J.
„ 11 -	10 45 0	4	From 240½° + 62½° to 237° + 47°. Very rapid. Streak. Perseid.—W. F. D.
„ 11 -	10 48 30	>1	From 52°+55° to 55°+53°. Swift. Streak.—W. E. B.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 11 -	10 57 0	>1	From 21°+26° to 16°+11¼°. Rapid. Streak. Perseid. —W. F. D.
„ 11 -	11 27 0	Bright	From 328½° + 65¼° to 276½° + 34¾°.—T. E. R. P.
„ 11 -	11 31 15	>♃	From 343° + 51° to 323° + 41°. Swift. Golden, flashing at end and perhaps deflected.—E. R. B.
„ 11 -	11 50 0	Sirius	From 187° + 53° to 200° + 71°. Swift. Streak.—H. C.
„ 11 -	11 58 0	1	From 6° + 23° to 359° + 10°. Orange. Streak.—H. C.
„ 11 -	12 1 0	Sirius	From 17°+69° to 347°+71°. Slowish. Orange. Bright streak. ? Camelid.—E. R. B.
„ 11 -	12 23 0	Sirius	From 37° + 14° to 37° + 7°. Swift. White.—E. R. B.
„ 11 -	12 23 30	♃	From 14½°+ 29° to 6° + 16°. Rapid. Flash. Streak. Perseid.—W. F. D.
„ 11 -	12 24 0	♀	From 57⅓° + 55° to 67° + 50°. Swift. Bluish. Streak. —W. E. B.
„ 11 -	12 24 0	1	From 185°+73° to 195°+62°.—H. C.
„ 11 -	12 25 0	Sirius	From 331°+32° to 331½°+39°. Swift. White. Golden streak.—E. R. B.
„ 11 -	12 27 0	1	From 40° + 62½° to 37° + 66°. Orange. Narrow green streak, near radiant. H. C.
„ 11 -	13 2 0	♃	From 350° + 76° to 380° + 73°. Very swift. White.— E. R. B.
„ 11 -	13 11 0	♃	From 20¾° + 1° to 18° + 11°. Rapid, flash, streak. Perseid.—W. F. D.
Sept. 3 -	7 3 0	2×♀	Seen in twilight and path estimated from 6° + 53° to 32° + 58°. Slow. 2 secs. White, no train.— T. H. ASTBURY, Wallingford.
„ 15 -	8 18 0	♃	From 11° + 39° to 333° + 26°. Slowish, bright streak. Radiant, 61° + 36°.—W. F. D.
„ 15 -	8 56 0	Sirius	From 17h. 30m. + 40° to 17h. 10m. + 17°. Quick. 2 secs. Yellow, with narrow streak. — J. M. WADMORE, Exmouth.
Oct. 3 -	6 15 0	♀	From about 40° above S. horizon, fell 15° towards S.W. —G. T. DAVIS, Reading.
„ 18 -	13 24 0	♀	From 87° − 1° to 105° − 10°. Bluish white. Swift. Arietid.—W. E. B.
„ 31 -	8 50 45	♃	Burst out 15° S.W. of γ Arietis, increased in brightness and vanished 10° beneath γ Pegasi.—S. J. J.
Nov. 6 -	10 24 30	♃	From 40 Ceti, passed between η and θ Ceti; also 7° E. of β and proceeded 1° further, momentary train.— S. J. J.
„ 13 -	15 26 0	Sirius	From 179° + 22° to 185½° + 21½°. Duration ·7 sec. Bluish, appeared to explode. Leonid.—J. H. B.
Dec. 12 -	12 29 0	♀	Magnificent, various colours, for the last 3° or 4° green with red train. Geminid, passed π^6 Orionis and o^3 Eridani, going 2° or 3° further. Course about 20°. Quick. Duration 2·3 secs.—T. W. B.
„ 13 -	14 23 30	♃	From 106½° + 16½° to 107⅓° + 7°. Geminid. Quick, small round head.—W. E. B.

Observers—E. R. BLAKELEY, Dewsbury.
T. W. BACKHOUSE, Sunderland.
W. E. BESLEY, Westminster.
W. F. DENNING, Bristol.
H. CORDER, Bridgwater.
REV. S. J. JOHNSON, Melplash, Bridport.
REV. T. E. R. PHILLIPS, Hendford, Yeovil.
H. J. TOWNSHEND, Leeds.
Place of observation as above, unless otherwise stated.

Report on the Auroral Displays of 1898.

As it is only recently that the suggestion was made for Members to report auroral observations to the Director of the Meteoric Section, not very much has been done to get together details of last year's displays. The report will be therefore, a short one, and also for the reason that at this time of scarcity of sun-spots, Auroræ are also infrequent. The one fine display of September 9 has already been described at some length in the "Journal," so that a brief record of it here from several observers is all that will be needed.

Many observers, especially those living near towns, where the sky is often more or less illuminated, would doubtless hesitate to record as an aurora a mere faint light in the northern sky, and, of course, towards the summer it becomes increasingly difficult to differentiate them from the zodiacal light, the Milky Way, and twilight.

In the winter it is more easy, and it will be found an interesting plan always to examine such glows with a spectroscope, when the greenish auroral line will very often decide the point, although sometimes it may be too faint for small instruments.

In the future it will be advisable for observers in reporting to the Director, to describe what form the display takes, whether it consists only in a faint glow, whether a distinct arch of light is seen, or streamers appear, or lastly, whether the corona is formed overhead, with the various accompaniments of a really great display. Careful note should be made of the time and position or path of any shifting patches or broken arches of light or specially brilliant streamers.

In the early months of 1898, no auroras seem to have been recorded, but in April some were seen in Scotland, and on April 12, there was a display reported by Mr. Forsyth, at Macduff, N.B., as "fairly extensive, but not bright." At Bridgwater, it was not seen until about 9.10, when a bright glow was noticed along the northern horizon, with sheaves of pale streamers. At 9.20, there was a rather brilliant patch of light in the N.E., which travelled slowly to the N., when it threw up some long streamers, one resembling a curved comet's tail, probably from a secondary streamer forming by the side of the upper part of it. After 9.30, the display waned.

GREAT AURORA OF SEPTEMBER 9.

Several reports of this phenomenon have already been published; to which may be added a note by Mr. J. H. Astbury, of Wallingford, on the Arch of Patches of Light in the S., which he had described in the "Journal" (Vol. IX., p. 25). When first seen, these clouds were just to the S. of θ Aquilæ, and it was curious to note "the manner in which the patches moved across the sky. "They did not simply move as clouds, but the leading (eastern) "end of the patches extended by a very rapid succession of tiny "tongues of light, which appeared to leap over each other from "the end of the patch in a way which I can only compare with "the strong ebullition of molten metal. There was little, if any, "contraction at this end, but at the western end the extension

" and contraction were both very strongly marked, and were of " the whole width of the patches. The width remained nearly " constant throughout their course, though it varied in the " different patches. I did not see anything of the southern " display after about 8.25, by which time it had descended to the " horizon."

Mr. J. E. Clark, of South Croydon, notes that the display, especially the southern arch, was like a shifting search light. At 9.30, there were streamers W. of magnetic N., with a very distinct spectrum. Earlier in the evening some were tinted with red. At 11 o'clock, the lower edge of the arch was sharply defined. At mag. N., the altitude of the top above the horizon was twice the distance between α — β Ursæ Maj., and was distant in azimuth, once the distance between α—β, W. from N.

Rev. S. J. Johnson reports the display as brilliant: " At 9.20, " as a considerable illumination over a fourth of the horizon from " Arcturus due W., to a point due N., being especially bright " beneath α and β Ursæ Maj. Two streamers, one stretching " beyond β and γ Ursæ Minoris, the other across δ and ϵ. A few " faint streamers after this. At 9.50, the illumination contrasted " strongly with some small black clouds above the W.N.W. " horizon. About 10.5, a deeper yellow colour was noted. At " 10.20, the aurora had faded, but at 11.30, it was again present " with bright low streamer in the N.W."

The Director observed from Clifton Down, and at first, soon after dark a bright display was noticed, somewhat tinged with red, but clouds came over, and hid it for some time. At 10.30, it was brilliantly clear, with a green arch along the N.W. horizon, and occasional streamers through the Great Bear. At 9.50, especially, there were four or five, one being very narrow and sharp. All were to the W. of the Pole Star, and moving slowly from E. to W. Bright light extended some distance E. of N., but the whole display was centred far to the W. of that point.

About midnight, it was still very clear, and the auroral light very beautiful, with brighter streamers, but I do not think I saw any form W. of the Pole Star at any time.

At Bridgwater, no other displays than these were recorded during the whole year.

At the time of the April aurora, sun-spots were very scarce, but as will be remembered there was an extremely fine one at the time of the September display, " the spot having crossed the central " meridian of the sun about 14 hours before the magnetic dis- " turbance set in, which was at its height from 8 to 11 o'clock on " Friday, September 9," as described by Mr. Maunder.

Errata.

In Report for 1897, page 5, in Remarks on April, *for* " Leonids " *read* " Lyrids." Page 10, Meteor of August 4, the time *should read* " 10.33, and the meteor passed $\frac{1}{2}^{\circ}$ 'left' of κ Cephei," *not* " East."

SECTION FOR THE OBSERVATION

OF

THE SUN.

DIRECTOR.—REV. A. L. CORTIE, S.J., F.R.A.S.

EIGHTH REPORT OF THE SECTION, 1898.

Introduction.

The present Report is mainly due to the energy and devoted industry of Miss Brown, the late Director of the Section. Almost the whole of the sheets for the Calendar and for the Ledger had been drawn up at the time of her death. The work of the present Director has been chiefly confined to a careful revision of the manuscript. In this work the proof sheets for 1898, of the invaluable series of Greenwich measures of the positions and areas of sun-spots, courteously supplied by Mr. Maunder, and the series of Stonyhurst drawings of the solar surface, have been of very great assistance. By this means the comparatively few gaps in the continuity of the record for the year which existed have been filled up.

The total number of groups recorded in 1898 was only 91, and the days on which no spots were seen amounted to 38. The following table, prepared by aid of the reports so far published, exhibits the rise and fall in the number of groups observed each year, and the corresponding decrease and increase of the days on which no spots were seen on the visible solar disk during the last eight years. It will be noted that the rise to the maximum number of groups in the year 1893, from the year 1891, was somewhat more rapid than the decline from 1893 to 1897. The

fourth column in the table gives the number of days each year on which no record appear in the reports:—

Year.	Groups.	Number of Days of no Spots.	Days of no Record.
1891 - -	130	16	0
1892 - -	224	0	44
1893 - -	285	0	22
1894 - -	279	0	27
1895 - -	234	0	33
1896 - -	161	3	18
1897 - -	130	21	31
1898 - -	91	38	0

The records for the year 1891 were filled up by the aid of the Greenwich volume, as stated in the Report for that year. During the period from March 28, 1891, to April 14, 1896, or for more than five years, the observations published in these reports show that there was no day on which the sun was free from spots.

Of the 91 groups observed during the year 1898, at least two-thirds were composed of small or insignificant spots. Fifteen of the groups belonged to six separate disturbances, and five more of moderate area (groups 55, 56, 57, 59, 60) crossed the disk in the last days of July and the first half of August. The longest period without any spots was the 13 days, July 2–14. But one group, that which reached its greatest development in the month of September, was not only remarkable in itself for its great size, but still more, in that it appeared at a period in the cycle of solar activity, when the minimum was fast approaching. In area, when at its greatest phase (2235 millionths of the visible hemisphere), it did not fall far behind any of the largest spots of the last two maxima. It is noteworthy, too, that the previous year 1897, at least three years after the maximum, was marked by the enormous group of the month of January, probably the greatest recorded during the last two cycles. It is a well-established fact that the descending arms of the curves of solar activity are much less steep than the ascending arms. Is it also true that the years of decline are marked by these occasional great outbursts of the seemingly pent-up solar energies before their final subsidence? The point is worth inquiring into.

The particular group under discussion crossed the visible disk four times, being first seen on August 11, and last seen on November 7. Its history is given in the "Ledger" under the numbers 61, 66, 73, and 79. It is illustrated by a beautiful drawing by Mons. Antoniadi, published in the "Journal," Vol. IX., No. 12, page 70, and it has been considered sufficiently important and interesting to receive further illustrations of its appearance, during its second and third passage across the disk, from sketches by Mr. Corder, Mr. Astbury, and Prof. Pereira. During its first appearance (group 61) it consisted of a few insignificant dots, and

its last appearance (group 79) was of a precisely similar character. Magnificent faculæ of great extent clustered thickly round it when it reached the W. limit of the sun on October 12, at the end of its second transit of the visible disk. Prof. Pereira's drawing of October 6 shows the "black holes" in the umbra, as also a bright bridge very conspicuously. We cannot, however, subscribe to his opinion, expressed in his note, that these conjoined phenomena are conclusive against a possible elevation of the spot on the solar surface.

Great industry has been displayed by the observers of the Section in noting the first beginnings of an outburst of spots, especially by Mr. Bartlett, and by Mr. Hadden, who has supplied a very complete catalogue and description of nearly all the groups recorded. From these observations about six cases were found which could be utilised in studying the connection between the faculæ and the first beginnings of a spot disturbance, a subject to which the present Director called particular attention in a paper printed in the "Journal," Vol. IX., No. 3, and which can be more easily studied at the minimum than at the maximum period of solar activity. Up to the present time Father Sidgreaves, from a careful study of a selection of the Stonyhurst series of drawings, has found six cases in which faculæ certainly preceded the first beginnings of the spot group and three other probable cases. From the materials I have been able to discuss, I have found one more certain case. It occurred in the group which crossed the disk in the first days of November, and which died on the visible hemisphere during its second passage on December 2. The following table in which a summary of its life history is given will enable observers to study the matter for themselves from the Greenwich publication, and from our Report.

Group B.A.A.	Number Greenwich.	Max. Area.	Mean Heliographic.		Central.	First seen.	Last seen.
			Long.	Lat.			
80	4807	680	200	+6	Nov. 5	Oct. 31	Dec. 2
85	4816	30	211	+5	Dec. 1		

The observations are as follows:—On October 30 two small compact bright patches of faculæ were drawn at Stonyhurst at the E. limb of the sun at 11.50 a.m., in the position longitude 199° and latitude from +5° to +8°. They had all the characteristic appearance of new faculæ; and, moreover, no disturbance of the solar surface by either spot or faculæ had been recorded in this region (as a study of the positions in the Greenwich volume shows) since August 11, when a group of faculæ was measured at longitude 200·7° and latitude +12·5°; that is, during a period of about three solar rotations. The Greenwich photograph, one of the Indian series, taken at $7^h\ 38^m$ a.m., does not record the faculæ. No drawing was made at Stonyhurst on

October 31 ; at $8^h\ 10^m$ a.m., Miss Brown observed and saw no spots, but at $9^h\ 15^m$ Mr. Bartlett saw a few hardly perceptible spots near the E. limb. They were probably too faint to be shown on the photograph taken at Greenwich at $12^h\ 40^m$, for they are not recorded, but the position of the faculæ is given at longitude 203·3° and latitude +8·1°. The next day, November 1, the spot group was photographed at Greenwich, at mean position longitude 202·1° and latitude +8·3°. This evidence of the connection of spot-group and faculæ is corroborated by the Stonyhurst drawing of the same date. During the second rotation the group consisted of a few small spots.

NAMES of MEMBERS of the Section.

Name.	Address.	Instrument.	——
ASTBURY, J. H.	Wallingford	3½-in. O.G.	Drawings (projection).
BARTLETT, J.	Bramley	4-in. O.G.	„ „
BELL, J. E.	Sydney, N.S.W.	„	„ „
CORDER, H.	Bridgwater	6½-in. Spec.	„ „
CORTIE, Rev. A. L.	Stonyhurst	15-in. O.G.	Drawings, measurements of position.
ELD, The Rev. F. J.	Polstead Rectory.	8½-in. Spec.	Measurements of position. Tracings.
HADDEN, DAVID E.	Alta, Iowa, U.S.A.	4-in. O.G.	Daily record.
PEREIRA, J. DE MORAES.	Azores	4½-in. O.G.	Drawings and measurements of position.
SIMPSON, DAVID G.	Denmark Hill, London.	„	Drawings (projection).
SMART, Dr. D.	London	10-in. Spec.	Photographs and measurements of position.
SOLÁ, JOSÉ COMAS	Gerona, Spain	—	——
TOWNSEND, J. S.	Sevenoaks	4½-in. O.G.	Photographs, diagrams, and measurements of position.
WADMORE, J. M.	Exmouth	3-in. O.G.	Direct vision.
WAUGH, The Rev. W. R.	Portland	4½-in. O.G.	Drawings (direct vision).
WHICHELLO, Dr. H.	Chester	„	Drawings (projection).

Calendar of Sun-spots and Faculæ.

JANUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	1, 2	(A few small spots near W. limb at 8.30 p.m seen by Mr. Hadden. No. 129 of December 1897.)
2	1, 2, 3, 4	W. 5° to 15° N. One patch to the S. f. group 129 of December 1897?
3	1, 2, 3, 4	E. numerous, region of 4. Not observed on the 2nd.
4	1, 2, 4	E. region of 4.
5	1, 2, 4	E. region of 4. W. position of 1.
6	1, 2, 4	E. still visible round 4. W. position of 1.
7	1, 2, 4	E. a little S. of equator, faint but numerous. W. chiefly to the N. of 1.
8	2, 4	W. 14° to 17° S.
9	2, 4	W. region of 2.
10	2, 4	W. same latitude.
11	4	W., S. of equator, some distance from limb.
12	4	W.
13	4, 5	(Two dots near E. limb, possibly belonging to group 6.)
14	4, 5	E. conspicuous, S. f. 5.
15	5, 6	E. round group 5, especially the f. spot.
16	5, 6, 8	E. region of group 8.
17	5, 6, 8	Central 5, following 8.
18	5, 6, 7, 8	E. central 8.
19	5, 6, 7, 8, 9.	
20	5, 6, 7, 8, 9.	
21	5, 6, 7, 8, 9.	
22	5, 6, 7, 8, 9	E. numerous, half-way between 9 and limb. W. round 6 and 7.
23	5, 6, 7, 8, 9	E. 3° to 15° S.
24	5, 7, 8, 9	E., W. central 7, following 5.
25	5, 8, 9	E. following 5.
26	8, 9.	
27	9.	
28	9.	
29	9.	
30	9	W. (a bright ridge extending along 9 on the W. side).
31	9	W. extensive 5° N. (position of 9). Slight on E.

FEBRUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	No spots.	
2	No spots.	
3	No spots.	
4	10, 11.	
5	10, 11	E. numerous, region of 11, one patch far from limb. Central 10.
6	10, 11	E. numerous, about 11 and following.
7	10, 11, 12 13	E. 2° to 9° S. Position of 13 and a patch to the N.
8	10, 11, 12, 13	E. region of 13. W. region of 12.
9	10, 11, 12, 13, 14	(A small spot S. f. 10, about 20°, not numbered.) E., especially N. of 13 and 14. W., S. p. 12.
10	10, 11, 13, 14	E. 5° to 16° S. W. 17° to 30° N.
11	10, 13, 14	E. f. 14 W. Same position as on the 10th.
12	10, 13, 14, 14A	E. Two dots in faculæ. W. 0° to 16° S.
13	13, 14	E. on a line with group 14, but far behind. W. bright, same position as 12th.
14	13, 14	E., same as on the 13th. W., a patch to the S. far from limb.
15	13, 14, 15, 16, 17	E. 0° to 15° N. 0° to 5° S.
16	13, 14, 15, 16, 17	E. 0° to 10° N. around 16 S.
17	13, 14, 14B, 15, 16, 17, 18, 19.	
18	13, 14, 14B, 16, 17, 18, 19.	
19	13, 14, 16, 17, 18, 19.	
20	14, 17, 18, 19	W. region of 14. Numerous.
21	17, 18, 19	Bright patch W. N. of place of 14.
22	17, 19, 20	E. round 20.
23	17, 19, 20	E. region of 20, and some distance to the N. Round 17 and 19. Compact.
24	17, 19, 20	E. region of 8 to N. of 20. Branching round 17 and 19.
25	17, 19, 20	W. 0° to 15° N. 0° to 7° S.
26	17, 19, 20	W. 0° to 12° N. 0° to 5° S.
27	20, 21.	
28	20, 21	E. 0° to 15° S. Also two separate patches more N.

MARCH 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	20, 21	E. 2° to 14° S. Compact about the spot 20.
2	20, 21	E. f. group 21, numerous. Compact about 20.
3	20, 21, 22, 23	E. 8° to 15° S.
4	20, 21, 24	E. region of 24. W. one patch, lat. of 22.
5	20, 21, 24, 25, 26	W. round and S. of 20.
6	21, 24, 25, 26, 27.	
7	21, 24, 25, 26, 27	E. region of 25, 26, 27. Especially bright N. of 27. Position of February train.
8	21, 24, 24A, 25, 26, 27	E. f. 27. Two or three small spots near W. limb in S. lat. ; also on the 9th.
9	21, 24, 24A, 25, 26, 27.	
10	21, 24, 24A, 25, 26, 27	E. faint, f. 26 and 27. W., S. f. 21.
11	21, 25, 26, 27	W. region of 21.
12	25, 26, 27	W. on a line with 25.
13	25, 26, 27	E. extensive (a dot in N. lat.). Faint spots near centre of disk observed only by Mr. Hadden, also 14th and 15th.
14	25, 26, 27.	
15	25, 26, 27	W. round 25, 26, 27.
16	25, 26, 27, 27A	E. conspicuous round 27A.
17	25, 27, 27A, 27B	W. region of 25. A few in N. lat. region of 25.
18	27.	
19	No spots	(Two dots near centre of disk, seen only by Mr. Hadden.)
20	No spots	W. small patch near limb.
21	28. 29?	Groups 28 and 29. Probably those seen by Mr. Hadden. Greenwich and Stonyhurst no spots.
22	28, 29	(One small spot W. about 17° S. lat.) Not in Greenwich series.
23	No spots.	
24	No spots	E. far from limb. W. one patch far from limb.
25	30	E. round 30. W. slight faint patch.
26	30.	
27	30.	
28	30	E. limb extensive.
29	30	E. 7° to 20° S. Some far from limb.
30	No spots.	
31	31, 32	E. p. 32.

APRIL 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	31, 32	E. 3° to 20° S. extensive.
2	32	E. 0° to 23° S.
3	32	E. 0° to 26° S.
4	32	E. 0° to 4° N. 0° to 25° S. Very extensive from 32 to E. limb.
5	32	E. 12° S., W. 5° to 10° S., and 15° S. Conspicuous far from limb.
6	32.	
7	32	Small patch E. limb.
8	32, 33	W. 10° to 12° S.
9	32, 33.	
10	32, 33	W. p. and surrounding group 32.
11	32, 33	W. round 32 extensive.
12	32, 33	W. region of 32. Beautiful branches.
13	32, 33	W. round 32, and far to the S. Also around 33.
14	No spots.	
15	No spots	W. position of 32.
16	No spots.	
17	No. spots,	
18	No spots.	
19	No spots	E. two patches. W. one patch
20	No spots.	
21	No spots	E., a small patch to the N. W. further from limb.
22	34	E. 20° or more S. W. 10° S
23	34	E. region of 34.
24	34	E. round and f. 34.
25	34, 34A.	
26	34A, 34B	E. region of 34B.
27	34A, 34B	E. extensive near limb.
28	34A, 34B	E. with a small spot f. 34B.
29	34A, 34B	Region of 34A.
30		A few small spots.

MAY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1		Three spots, Stonyhurst, near W. limb. Greenwich group 4722.
2	34, 34A, 35.	
3	35	E. near limb. W. near limb.
4	35.	
5	35, 37	E. conspicuous around 37. W. far from limb to the S.
6	35, 35A, 36, 36A, 37, 38	E. a ring over penumbra f. 38 W. far from limb S.?
	35, 35A, 36, 36A, 37, 38	E. f. 38. W. near limb. S.?
8	36, 36A, 37, 38	Only observed by J. Comas Solá.
9	36, 36A, 37, 38.	
10	36, 36A, 38.	
11	36, 38.	
12	36, 38	Bright dot E. Stonyhurst, W. Greenwich and Stonyhurst.
13	38, 39	E. around 39.
14	38, 39.	
15	38, 39	W. numerous f. 38.
16	38, 39, 40.	
17	38, 40.	
18	38, 40, 41	E. 9° to 20° S.; f. 40, and in a ring to the N. of it. W. 3° to 13° S., region of 38.
19	40.	
20	40	E. numerous, with a dot a little N.
21	40	Many scattered near W. limb.
22	40, 40A	W. far from limb to the S.
23	40, 40A	W. far from limb, N.? Large atch near E. limb.
24	40, 40A	E. and W.
25	40, 40A	A small spot near E. limb in N. lat.; seen also on the 26th by Mr. Hadden.
26	40, 40A	Very bright compact masses about 40. E.
27	40A	W. region of 40 inconspicuous. E many faint patches.
28	40A, 42	Faint patches E. and W
29	40A.	
30	43, 44.	
31	43, 44.	

JUNE 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	43, 43A, 44	
2	43, 43A	A few dots not numbered in long. 101° lat. 6° N. Seen also on the 3rd.
3	43, 43A	W. region of group 43.
4	43A.	
5	43A, 45	E. with a dot near limb; also seen on the 6th.
6	43A, 45.	
7	43A, 46	W. bright round 43A, and a patch f. 46 E.
8	No spots	W. bright patch. Penumbral patch.
9	No spots	Magnificent faculæ W. Fainter patches E.
10	No spots.	W. Three minute spots near central meridian.
11	No spots	W. A pair of very small spots.
12	No spots	(A tiny pair not numbered near central meridian.)
13	47.	
14	47.	
15	47	E. near limb at 5.30 p.m. S.?
16	47, 48.	
17	47, 48	W. region of 47, bright and numerous.
18	47, 48	W. same lat. 10° to 29° N. Central to 48.
19	48	E. very extensive, lat. of 49. Bright patch W.
20	48, 49	E. region of 49, especially S. of it.
21	49.	
22	49	E., a patch at some distance from limb. Several scattered faint patches.
23	49	E., a few near equator. W. with a small spot not numbered.
24	49.	
25	49, 50, 51	W. bright to the N. and a narrow stream to the S. A small spot near central meridian at 6.15 p.m.
26	49, 50, 51	E. round 51.
27	49, 50, 51, 52.	
28	49, 51, 52	Surrounding the groups.
29	49, 51, 52	W., S. f. 49 extensive.
30	51.	

JULY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	51	W. latitude of 49°.
2	No spots	W.
3	No spots.	
4	No spots	E. extensive. N. Faint W.
5	No spots	E. 10° to 15° N. Long. about 269° to 257°. W. 4° to 14° S.
6	No spots	W. same lat., but nearer limb.
7	No spots	E. about 17° S. W. 0° to 14° S.
8	No spots	E. same lat. as on the 7th, further from limb.
9	No spots	Faint patches E. and W.
10	No spots	Faint patch W.
11	No spots	E., a few near limb.
12	No spots	E., very few.
13	No spots	A bright isolated patch 20° from W. limb.
14	No spots	W. faint.
15	53	W. same latitude.
16	53.	
17	53	E. to the S. Some far from limb. W. one bright patch N.
18	No spots	E. few, one patch bright. W. same lat. as on the 17th.
19	54.	
20	54	W. faint. Bright, compact about spot group.
21	54.	
22	54.	
23	54	E. to the S. Some far from limb.
24	54	E. 20° to 24° S.
25	56	E. with three very small spots. Position of faculæ on the 24th.
26	No spots	Few unstable evanescent spots.
27	No spots	W. about 3° N.
28	No spots	Few very small unstable spots.
29	55, 56.	
30	55, 56	E. region of 57 and p. W. about 10° S.
31	55, 56, 57	E. round 57 and to the S.

AUGUST 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	55, 56, 57, 58.	
2	55, 56, 57, 58, 59	E. region of 59. W. probably latitude of 55.
3	56, 57, 59.	
4	56, 57, 59	W. 5° to 10° S., far from limb. Surrounding 59.
5	56, 57, 59	W. region of 56.
6	57, 59.	
7	57, 59	W. extensive. Position of 56.
8	57, 59	W. same locality, nearer limb.
9	57, 59	Central to 57. Few faint patches W.
10	57, 59.	
11	57, 59, 60, 61	W. around and f. 57.
12	59, 60, 61	W. f. 59. S.W. region of 59.
13	59, 60, 61.	
14	60, 61	W. one patch near limb f. 59. E. limb to the S., with a small spot at 8.30 p.m. (Iowa) in N. lat.
15	60, 61	E. with two very small spots where faculæ appeared on the 14th.
16	60, 61	E. far from limb; seen also on the 16th and 17th.
17	60, 61	W. p. 61, and around 60
18	60, 61	W. bright, position of 61. Mr. Bartlett reports a dense mass to the N. of 60.
19	60	W. region of and S. of 60.
20	No spots	E. small, near limb.
21	62.	
22	62, 63	W. 13°. S.
23	62, 63	Central.
24	63	W. round and far S. of 63.
25	No spots	W. bright, position of 63 and a patch to the S. further from limb.
26	64, 65.	
27	64, 65	E. round and f. 65.
28	64, 65	E. circular patches f. 65.
29	65	E. extensive to the S. Two small spots a little E. of meridian in S. lat.
30	65	E. 10° to 22° S.; far from limb.
31	65	E. 10° to 30° S; extensive, far from limb. W. bright patch to the N., and one about 7° S.

SEPTEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	65	E. rather faint; position of 66? W. a few round small spots near limb.
2	65, 66.	
3	65, 66	E. 10° to 20° S.
4	65, 66	E. 7° to 24° S. A large mass between large spot and limb. Mr. Wadmore reports them as being very complicated.
5	65, 66	E. 6° to 20° S. W. preceding 65 for most part.
6	65, 66	E. f. group 66.
7	65, 66	W. f. 65.
8	66	Near W. limb, faint.
9	66	W. limb. N.?
10	66	E. 8° S.
11	66, 67.	
12	66, 67.	
13	66, 67	W. 10° to 31° S.
14	66, 67, 68	W. 10° to 25° S.
15	66, 67, 68, 69	W. 8° to 22° S. Conspicuous.
16	67, 68, 69	E. and bright patch round spot.
17	67, 68, 69.	
18	67, 69.	
19	67, 69	W. bright, f. 68. Round 67.
20	69	W. 4° to 18° N.
21	69	E. close to limb. Small but bright.
22	69	E. very bright, 0° to 6° N. Nearly position of 65.
23	69, 70	E. 14° N. and 0° to 10° N.
24	69, 70	W. region of 69.
25	70?	W. f. 69.
26	70?, 71	E. 10° to 20° S. (small flaky). N. region of 71.
27	70?, 71	E. two very bright patches to the S.
28	70?, 71, 72	E. round and N. of 72.
29	71, 72	E. 6° to 13° S. bright, p. 73.
30	71, 72, 73	E. f. 72 and region of 73. (Large group returned.)

OCTOBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	71, 72, 73	E. 0° to 20° S. (Return of large spot.)
2	71, 72, 73	E. 0° to 25° S. W. 0° to 10° N.; 0° to 9° S.
3	71, 72, 73	E. scattered patches, f. 73.
4	71, 72, 73, 74	Surrounding 71, f. 73.
5	72, 73, 74.	
6	72, 73, 74	E. 5° to 7° N. W. 10° to 14° N.
7	72, 73, 75.	
8	72, 73, 75	W. 20° N. Central 75.
9	72, 73, 75	E. 15° to 20° S. Central compact, 73; f. 75. W.
10	73, 75	E. Central, compact 73. Extensive W.
11	73, 75	W. limb large masses c. and f. 73, Central 75. E. detached patches.
12	75	W. 0° to 14° S. Fine mass of spreading faculæ.
13	75.	
14	75.	
15		A very small spot.
16	75.	
17	76.	
18	76A.	
19		A small spot.
20		A very small spot.
21		A very small spot. Patch of faculæ E.
22	77.	
23	77	E. Region of 77. W. 8° to 18° N.
24	77.	
25	77.	
26	77, 78.	
27	77, 78	Fine patches E. limb.
28	77, 78	E. 5° to 20° S.
29	77, 78, 79	Region of 79. Bright patch E.
30	77, 78, 79	E. Region of 79 extensive.
31	77, 78, 79, 80.	

NOVEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	77, 78, 79, 80, 81	Bright, 7° N. About 180° long. E. 0° to 10° S. Region of 81.
2	77, 78, 79, 80, 81	E, Round 81. W. conspicuous region of 77.
3	77, 78, 79, 80, 81	E. region of 81 and W. region of 77.
4	78, 79, 80, 81	E. around and f. 81.
5	79, 80, 81, 82	W. position of 78.
6	79, 80, 81, 82	W, 10° to 23° S., p. 79. (Last return of big spot.)
7	79, 80, 81, 82	P. and f. 79, very extensive W.
8	80, 81, 82	W. 10° to 30° S. (same).
9	80, 81, 82	Central 80.
10	80, 81A, 82	W. 3° to 16° N.
11	80, 81A, 83	W. scattered and faint patches.
12	81A, 83.	
13	82, 83	W. about 0° to 10° N.
14	83.	
15	83.	
16	83	E. to the N.
17		Two very small spots.
18	84.	W. Extensive far from limb. About 3° to 10° S. Position of 86?
19	84	E. and W. bright.
20	84	W. 7° to 17° S.
21	84.	
22	84.	
23	84.	
24	84.	
25	84.	
26	84, 86	W. region of 86.
27	86	Numerous around 86.
28	85, 86.	
29	85, 86	Patches E limb.
30	86	E. 5° to 17° S.

DECEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	86.	
2	86, 87.	
3	86, 87.	
4	86, 87	W. 15° to 25° S.
5	86, 87.	
6	86, 87.	
7	86, 87	W. 5° to 10° N. Long. about 211° to 206°, nearly position of 80. (85 a return of it.)
8	86, 87	W. S. of 86. A small patch far from limb.
9	87	W. 7° to 14° S. Long. 182° to 174°. The f. nearly position of 81, ? and 14° to 16° S. Long. 172°.
10	87	Patches E. and W. small.
11	87.	
12	87.	
13	87	E. bright. 8° to 13° S. W. region of 87.
14	No spots.	
15	No spots	E. faint, far from limb. Penumbral patch.
16		Small spot.
17		Small spot.
18	88	E. round 88.
19	88	E. region of 88.
20	88	E. A very few to the S.
21	88.	
22	88 ?	E. few and faint, 14° to 23° S.
23	No spots	E. About 7° to 13° N. Long. 220° to 210°, nearly position of 80, and 23° S. Long. 220°.
24	No spots.	
25	No spots.	
26	No spots.	
27	No spots.	
28	89	E. S. f. group 89, some far from limb. Position of 90 ?
29	89, 90.	
30	89, 90	E. 16°/17°. Long. 138° to 128° nearly position of 87.
	89, 91	E. around 91.

Sun-spot Report, 1898.

LEDGER.

Jan. GROUP 1. *Long.* 311°. *Lat.* 15° N.

1–7. A normal spot, near the central meridian on the 1st, major axis about 30″. Little change took place before reaching the limb. 128 of December 1897.

Jan. GROUP 2. *Long.* 270°. *Lat.* 8° N.

1–10. A normal spot. Nucleus partly bridged on the 3rd and 4th. Major axis 25″ on the 7th. It decreased rapidly before disappearance by rotation. (Group 130 of December 1897.)

Jan. GROUP 3. *Long.* 253°. *Lat.* 12° N.?

2–3. Two faint little spots; on the 3rd only one.

Jan. GROUP 4. *Long.* 210°. *Lat.* 11° N.

2–14. A normal spot seen by Mr. Hadden (in Iowa) at 5 p.m. on the 2nd. It showed little change before reaching W. limb (at 4.18 p.m. on the 14th) except some signs of disruption on the 8th and 9th. In major axis it hardly exceeded 35″. Penumbra when near W. limb on the p. side. (A return of the leading spots of Group 124 of December 1897.)

Jan. GROUP 5. *Long.* 64°. *Lat.* 10° S.

13. A normal spot observed by Mr. Hadden in Iowa, close to E. limb at 5 p.m.
14. Penumbra wider on the f. side, nucleus bulging to the S. A misty trail s. f.
15. Two medium sized spots, the f. probably developed from the trail above mentioned.
16. The p. with large nucleus, the f. more dispersed.
19. One spot; major axis 35″.
20. Little change.
21. Decreasing; two small spots f.
22. Broken up at the rear.
23. Near limb.

Jan. GROUP 6. *Long.* 99°. *Lat.* 15° S.

15. A few dots.
16. Nine small spots.
19. A medium sized spot with divided nucleus, several small ones p. some distance apart.
20. Very much reduced; penumbra on the p. side only.
21. Nebulous; no distinct penumbra, one spot p.
22. Solitary and still more reduced.

Jan. GROUP 7. *Long.* 89° to 85°. *Lat.* 6° S.

19–23. A spot about 25″ in major axis, vertically inclined, with a little stream following, which soon decreased, the leader also dwindling.

Jan. GROUP 8. *Long.* 35°. *Lat.* 9° N.

16–23. A normal spot; major axis 30″, nucleus bridged on the 22nd and and 23rd. It showed little change, and must have decreased rapidly, not being visible on the 26th. (Four nearly normal spots were visible on the 19th.)

Jan. GROUP 9. *Long.* 358°. *Lat.* 5° N.

19. A considerable spot near E. limb.
20. Nucleus curving westward.
21. Normal, fimbriated.
22. Larger, 1′ of arc in diameter, a portion to the W. almost severed.
23. Small spots f. (not observed by members in England after this date).
26. More outliers.
27. Several portions dividing and embracing more than half of the circumference.
28. Still more broken up.
29. Only two of the smaller fragments with nuclei.
30. Nucleus single, penumbra long, oval. A bright ridge of faculæ extending along the edge nearest the limb. Whole appearance strongly suggestive of the depression theory.
31. Close to limb at 12, appearing as a long dark line, without penumbra.

Feb. GROUP 10. *Long.* 176° to 171°. *Lat.* 6° to 8° S.

4–12. Three small spots. A new outburst, with slight penumbra on the 5th. More in number, but smaller on the 7th. Not seen at 9.45 a.m. on the 8th, but observed by Prof. Pereira at 0.18. One increased a little in area, the rest gradually dying out.

Feb. GROUP 11. *Long.* 145°. *Lat.* 11° S.

4–10. A small nebulous spot which did not increase, and vanished before reaching W. limb.

Feb. GROUP 12. *Long.* 229° to 224°. *Lat.* 10° N.

7–9. Two spots with slight penumbra in the western hemisphere. The f. increased a little, penumbra wider on the p. side; on the 8th the p. soon disappeared.

Feb. GROUP 13. *Long.* 102°. *Lat.* 8° S.

7–19. A small normal spot near E. limb on the 7th. Nucleus double on the 9th; cloven on the 12th and 13th; elongated and entire when near the central meridian, with major axis 35″. It decreased before reaching the limb.

Feb. GROUP 14. *Long.* 97° to 83°. *Lat.* 5° to 8° S.

9. A few insignificant spots near E. limb. (Positions of Group 7.)
10. Rather more in number.
11. A wide stream, three spots with slight penumbra.
12. Great increase, the leader and the last spot much larger, both bridged, many smaller ones between in curves.
13. The p. quadrangular, the f. with both nucleus and penumbra curving westward, intermediates more in a line.
14. The f. nearly vertical, bridged to the S. but less curved, intermediates larger. Length of train, including Group 13, 129,960 miles. The f. spot 66″ in major axis.
15. The p. bridged, the f. broken up to the S. and merging into the intermediates, which are again altered in form and position.
16. The p. again curved, the f. with three nuclei, all of them bridged, the rest also more separated and smaller.
17. The p. two-lobed, the f. very disjointed and curving to the S.
18. The p. bridged, lesser spots fast disappearing, leaving a larger but still fragmentary one at the rear.
19. Much foreshortened, the p. normal; the rest much reduced.
20. Only the f. visible at noon.

Feb. GROUP 14A. *Long.* 87°. *Lat.* 3° N.

12. A very small pair N. f., Group 14, On the 13th and 14th several single spots widely separated appeared in advance.

Feb. GROUP 14B. *Long.* 72°. *Lat.* 9° S.

17–18. Two small spots f. Group 14.

Feb. GROUP 15. *Long.* 121°. *Lat.* 10° S.
15–17. A little cluster. On the 17th in two sets near W. limb.

Feb. GROUP 16. *Long* 16°. *Lat.* 14° S.
15–19. A small double spot, with a few outliers at some distance from E. limb on the 15th, single on the 16th and 17th; afterwards a few very small spots in a line.

Feb. GROUP 17. *Long.* 2°. *Lat.* 6° N.
15–26. A normal spot, major axis about 40″, bridged in two places on the 18th and 19th, in form like the figure 3 on the 20th; afterwards with two nuclei. (Forming a triangle with Groups 18 and 19.)

Feb. GROUP 18. *Long.* 9°. *Lat.* 1° S.
17–21. A few small spots, with slight penumbra on the 18th, varying a little in position.

Feb. GROUP 19. *Long.* 2°. *Lat.* 1° S.
17–26. A normal spot, resembling 17, bridged on the 18th, curving westward on the 19th and 20th, with three nuclei on the 22nd, dots p. on the 23rd, nucleus single on the 25th. When near limb slight penumbra on the f. side and bright faculæ on the p. (In nearly the same position as Group 9.)

Feb. GROUP 20. *Long.* 267° to 259°. *Lat.* 8° to 11° S.
22. Two very small spots near E. limb.
23. One spot.
25. With two nuclei and a little penumbra.
26. More activity. Small spots and dots p.
27. Two considerable spots.
28. Two normal spots nearly equal in area, the f. about 40″ in major axis, with a few outliers.
Mar.
1. Both with divided nuclei.
2. The f. broken up to the N.
3. The p. broken up to the S. The f. fast decreasing.
4. Both very small.
5. One spot, still more reduced.

GROUP 21. *Long.* 189°. *Lat.* 7° S.
Feb. 28–Mar. 11. Two little spots, with a few outliers on March 5. The p. increased a little in area, attaining 25″ in major axis on the 4th and 5th. The f. about half as much. On and after the 10th the p., somewhat reduced, only remained.

Mar. GROUP 22. *Long.* 279° to 276°. *Lat.* 7° to 9° N.
3. A wide pair of faint spots in the western hemisphere.

Mar. GROUP 23. *Long.* 178°. *Lat.* 14° S.
3. A small faint spot S. f. Group 21.

Mar. GROUP 24. *Long.* 150°. *Lat.* 8° S.
4–10. A spot with slight penumbra showing but little increase; small spots and dots f. One only observed on the 10th.

Mar. GROUP 24A. *Long.* 159°. *Lat.* 10° S.
8–10. A few very small spots and dots, which varied in number, preceding Group 24.

Mar. GROUP 25. *Long.* 128° to 110°. *Lat.* 10° to 13° S.

5. A small penumbral spot near E. limb.
6. Two spots nearly equal in area.
7. Both increased, many small nuclei and a few outliers.
8. A broad stream, much subdivision.
9. Components still more numerous.
10. Changing rapidly, some of the spots amalgamating. Mr. Townsend observed reversals of the C. line over one or two of the p. spots and faculæ.
11. On the central meridian, nuclei larger, the final spot now quite distinct from the rest.
12. About five considerable spots p. One exceeding the rest in area and very compound, nucleus shaded off.
13. Still changing. Nucleus of chief spot 1′ of arc in length.
14. Nucleus less elongated but more complex. Final spot more broken up and spiral in form.
15. Train more simplified and in three sections, leading spot with a portion detached on the f. side. Chief spot a mass of nuclei, but evidently disintegrated, the interior lighter in tint than the rest.
16. Chief spot splitting up, the final fast disappearing.
17. Largest spot near limb.

Mar. GROUP 26. *Long.* 116°. *Lat.* 12° N.

5. A penumbral spot near E. limb.
6. Penumbra nearly equal E. and W. A smaller spot f.
7. The f. with two nuclei.
8. Bridged, the f. broken up.
9. Nucleus tripartite.
10. More abnormal.
11. A portion to the S. severed.
12. Reuniting.
13. Gaping to the N. Nuclei in a semi-circle, none f.
14. Four nuclei.
15. Penumbra disappearing.
16. Only two small spots, without penumbra.

Mar. GROUP 27. *Long.* 104°. *Lat.* 7° S.

6–18. A normal spot which showed but little variation except in the form of the nucleus, which was double on the 7th, had a small portion severed to the S. on the 13th, and to the N. on the 14th. Major axis 45″. A few small outliers preceded from the 12th to the 16th.

Mar. GROUP 27A. *Long.* 300°. *Lat.* 10° N.

16–17. A single small spot at some distance from E. limb observed only by Prof. Pereira and Mr. Hadden. Not recorded Greenwich or Stonyhurst. But fine faculæ about position seen at Stonyhurst, March 16.

Mar. GROUP 27B. *Long.* 1°. *Lat.* 6° S.

17. One or two very small spots seen by Prof. Pereira.

Mar GROUP 28. *Long.* 8°. *Lat.* 2° S.

21–22. A pair of very small spots in the western hemisphere.

Mar. GROUP 29. *Long.* 359°. *Lat.* 2° N.

21–22. Another little pair, probably observed by Mr. Hadden on the 21st.

Mar. GROUP 30. *Long.* 217°. *Lat.* 13° S.

25–29. One or two very small spots.

Mar. 31. April 1. } GROUP 31. *Long.* 173°. *Lat.* 15° S.
A little spot in the Eastern hemisphere, almost invisible. April 1.

Mar. GROUP 32. *Long.* 134° to 126°. *Lat.* 12° S.
31. A penumbral spot very near E. limb at 11 a.m. (A return of Group 25.)
April.
1. Nucleus double, a smaller spot f.
2. Nucleus very irregular, penumbra nearly equal but fainter on the f. side.
3. Nucleus singularly split up lengthwise.
4. A portion severed both to the N. and S. Major axis 55″, f. spot 30″.
5. Very complex, pointed to the N., f. spot circular.
6. Further change, many small nuclei; dots f. at some distance.
7. Elongated but decreasing, little penumbra, nuclei beaded, f. spot with more outliers.
8. Scattered fragments only, p. two veiled spots.
9. One small spot only p., the f. normal.
10. Little change, the veiled spots almost gone.
11. The f. only left; faculæ extensive.
12. Little change.
13. Very near limb, faculæ streaming to the S.

April GROUP 33. *Long.* 94° to 90°. *Lat.* 17° S.
8–13. A few dots on the 8th, E. of central meridian, increasing a little in number and area until after the 10th, when two, widely separated, only remained.

April. GROUP 34. *Long.* 202°. *Lat.* 10° N.
22–25. One or two very small spots.

April GROUP 34A. *Long.* 225°. *Lat.* 11° S.?
25–29. A few very faint spots, observed only by Prof. Pereira and Mr. Hadden. Two of them increased a little in area on the 29th.

April GROUP 34B. *Long.* 159°. *Lat.* 16° S.
26–29. At first two small spots near E. limb, as many as eight on the 28th and fifteen on the 29th.

May GROUP 35. *Long.* 84°. *Lat.* 14° N.
2–7. A few very small spots, seen only as dots by Mr. Hadden on the 7th at 1.15 p.m.

May GROUP 35A. *Long.* 53°. *Lat.* 8° N.
6–7. Six small spots between E. limb and Group 35, only observed by Mr. Hadden and Mr. Astbury.

May GROUP 36. *Long.* 60°. *Lat.* 11° S.
6–10. Three little spots, increasing in number, but after the 10th one only.

May GROUP 36A. *Long.* 34°. *Lat.* 13° S.
6–10. Two little pairs with slight penumbra, s.p. 38.

May GROUP 37. *Long.* 46°. *Lat.* 10° N.
5–9. A few very small spots reduced to one or two dots on the 9th.

May — GROUP 38. *Long.* 23° to 13°. *Lat.* 7° S.

6. Two medium sized spots following each other.
7. Penumbra chiefly confined to the N. and S., many outliers.
8. No details.
9. The p. with oval nucleus, the f. with a bright bridge extending partly through the p. portion of the penumbra, but not across the nucleus.
10. Both more normal. A drawing by Prof. Pereira shows the umbra of the f. bridged laterally.
11. Both nearly equal in area.
12. The f. with several small nuclei.
13. The p. carrot-shaped, elongating and breaking up at the extremity into a train of small spots. The f. with penumbra on the S. side only. Many outliers eastward.
14. The p. more parallel to the equator. The f. more vertical, whole group kite-shaped.
15. Decreasing. The p. with two nuclei, the f. breaking up and with only a little penumbra.
16. Leader much reduced.
17. Nearing limb.
18. A small single spot only visible.

May — GROUP 39. *Long.* 295° to 286°. *Lat.* 8° to 11° S.

13–16. Two or three small spots near E. limb. On the 16th reduced to one.

May — GROUP 40. *Long.* 244°. *Lat.* 16° S.

16–26. A small penumbral spot near E. limb at 6 p m. on the 16th. Stonyhurst seen 4.20 p.m. A smaller one f. in close proximity, which soon disappeared. Nucleus bridged on the 22nd. Major axis 20″, a few outliers to the S. After the 23rd smaller and more irregular.

May — GROUP 40A. *Long.* 207° to 200°. *Lat.* 16° S.

22–28. Two dots, seen at 8.30 p.m. by Mr. Hadden on the 22nd. Twelve on the 25th, decreasing in number on the 28th.

May — GROUP 41. *Long.* 268°(?). *Lat.* 13° N.

18. Three very small spots not far from E. limb.

May — GROUP 42. *Long.* 195°. *Lat.* 18° N.

28. A small spot in the western hemisphere, observed only by Mr. Townsend.

May 30 – June 3 — GROUP 43. *Long.* 158° to 152°. *Lat.* 19° S.

A stream of little spots, two with penumbra on June 1 and 2. Reduced to three on the 3rd.

June — GROUP 43A. *Long.* 105°. *Lat.* 0° to 2° N.

1–7. Two or three faint little spots on the 1st not far from the central meridian, increasing a little on the 5th. Near limb on the 7th.

June — GROUP 44. *Long.* 59°. *Lat.* 6° N.

1. A small spot near E. limb.

June — GROUP 45. *Long.* 68°. *Lat.* 12° S.

5–6. When first seen, a little pair not far from the central meridian.

June — GROUP 46. *Long.* 0°. *Lat.* 19° S.
7. Two faint little spots. Possibly seen by Miss Brown on the 5th.

June — GROUP 47. *Long.* 332° to 324°. *Lat.* 13° to 16° N.
13. Four very small spots (observed by Mr. Hadden at 1.45 p.m., and probably a reappearance of a dot seen by him on the 7th).
14. Little change.
15. A stream, the final spot only penumbral.
16. Solitary, a new spot to the S.
17. About five small spots, N. and S. of each other.
18. Near W. limb.

June — GROUP 48. *Long.* 238° to 230°. *Lat.* 17° to 18° N.
16. A cluster of very small spots 46° E. of the central meridian.
17. Two little streams, parallel to each other.
18. In one stream, about 15 spots; a small spot 8° S. f.
19. No longer a stream, but a few spots widely separated, rather more S. f.
20. Fast fading at 6.30 p.m.

June — GROUP 49. *Long.* 170°. *Lat.* 10° S.
20–29. A small normal spot, about 20″ in major axis on the 24th, decreasing rapidly afterwards, and invisible when near W. limb. A very few small followers.

June — GROUP 50. *Long.* 160°. *Lat.* 12° S.
25–27. One or two faint spots f. 49.

June 25–July 1. GROUP 51. *Long.* 86° to 78°. *Lat.* 5° to 7° S.
On the 25th a very small spot near E. limb; on the 28th three. (A veiled group closely f. was observed by Mr. Hadden on the 29th.)

June — GROUP 52. *Long.* 143°. *Lat.* 12° S.
27–29. One or two small spots following each other.

July. — GROUP 53. *Long.* 228° to 225°. *Lat.* 10° to 19° N.
15–17. A little cluster in the eastern hemisphere, in two sets, N. and S. o each other on the 16th; on the 17th one set only.

July. — GROUP 54. *Long.* 136° to 132°. *Lat.* 13° S.
19. A small spot near E. limb, with slight penumbra.
20. A smaller f.
21. Little change.
23. Both nearly equal, irregular.
24. More spots, three only with penumbra.
25. Fewer, in two sets. This group seems to have disappeared rather suddenly.

July. — GROUP 55. *Long.* 55° to 48°. *Lat.* 7° S.
29. A kite-shaped cluster of very small spots.
30. On the central meridian, more elongated, a little increase in area.
31. Two considerable spots, only dots between.

Aug.
1. Two pairs with very little penumbra, much more widely separated, no intermediates.
2. Fast decreasing, one spot p. two f. This group seems also to have vanished before reaching the limb.

July. GROUP 56. *Long.* 21° to 15°. *Lat.* 12° to 14° S.
29. A small spot at some distance from E. limb.
30. A few more f.
31. Leading spot larger than the rest, which are small and more in a stream.
Aug.
1. Leader with three nuclei.
2. Ear-shaped penumbra almost confined to the S., about six nuclei, one of the f. larger.
3. More normal and fewer nuclei. The f. scattered.
4. Quite dispersed, one nearly normal spot f.
5. Three principal spots nearly in a line.

July. GROUP 57. *Long.* 335°. *Lat.* 11° N.
31. A small penumbra spot near E. limb, a smaller f.
Aug.
1. Nucleus double, a portion of penumbra detached.
2. Ear-shaped, nucleus single, more spots f.
3. Major axis 1′ of arc.
4. Larger, vertically inclined, tapering at the upper extremity.
5. Two penumbral extensions eastward.
6. Little change.
7. Nucleus bridged. Two penumbral patches detached.
8. Solitary.
9. Signs of disruption in nucleus.
10. Normal, smaller.
11. Penumbra wider on the f. side.

Aug. GROUP 58. *Long.* 48°. *Lat.* 11° N. ?
1-2. A small nebulous spot in the eastern hemisphere.

Aug. GROUP 59. *Long.* 307° to 302°. *Lat.* 9° to 13° S.
2. A penumbral spot near E. limb with double nucleus.
3. A portion detached, major axis about 50″. Two spots f.
4. Compound, larger, detached portions appearing re-united, more f. spots, the two most easterly with slight penumbra.
5. Nucleus quadrangular.
7. Nucleus split up into oblong divisions.
8. Elongated, four distinct nuclei.
9. Drawn out length-wise in a carrot-like form, p. portion cleft. Major axis 1′ 30″, f. spots altered in form and position.
10. Decreasing, split in twain, each portion with elongated irregular nucleus.
11. More separated, each with two nuclei. At 10 a.m. the f. with surrounding penumbra; at 6 p.m. without any; the f. few and small.
12. Much foreshortened and reduced, f. spots in three sets.
13. One spot near limb. At 6.10 p.m. a mere dot on the edge.

Aug. GROUP 60. *Long.* 248° to 239°. *Lat.* 9° to 13° N.
11. A cluster of about six small spots at 10 a.m. More numerous at 6 p.m. with another more compact f.
12. At 8 a.m. a stream denser at the two extremities; near the central meridian. At 5 p m. with two penumbral, medium-sized spots.
13. Two very compound spots, major axis of each 45″ with a few intermediates.
14. Leading spot breaking-up, the f. with singular barred nuclei. A new penumbral spot to the S. At 8.30 p.m. (Iowa) decreasing, the f. with the larger nucleus of the two; many dots between.
15. Slowly decreasing, both more normal.
16. Little change, outliers fast vanishing.
17. Still on the wane, the two spots nearly equal in area.
18. Near limb, the f. only visible.
19. Close to limb at 4 p.m.

Aug. GROUP 61. *Long.* 236°. *Lat.* 10° S.

11–18. Two faint little spots on the 11th, a stream on the 12th. Final spot with slight penumbra on the 13th and 14th. Rapidly dying out afterwards and reduced to two dots on the 18th. Returned as Group 66.

Aug. GROUP 62. *Long.* 138°. *Lat.* 13° S.

21–23. A wide pair of very small spots.

Aug. GROUP 63. *Long.* 148° to 145°. *Lat.* 3° to 4° S.

22–24. Two pairs of small spots, widely separated. When near N. limb one only was observed.

Aug. GROUP 64. *Long.* 33° to 29°. *Lat.* 9° to 10° S.

26. A wide pair of penumbral spots on the central meridian.

27. Both with double nuclei.

28. Broken up and destitute of penumbra.

Aug. 26–Sept. 7. GROUP 65. *Long.* 339°. *Lat.* 9° N.

A normal spot varying but little throughout its course. In nearly the same position as 57.

Aug.

27. Penumbra wider on the f. side. Nucleus bridged in several places on the 28th, major axis about 50″.

31. A few outliers and two very small spots p. in long. 349°, lat. 7° to 8° N.

Sept.

1. When nearing N. limb smaller; faculæ closely surrounding on the 5th.

Sept. GROUP 66. *Long.* 244° to 228°. *Lat.* 11° to 16° S.

2. A large spot first observed by Mr. Hadden at 5 p.m. G.M.T., near E. limb. Penumbra to the N. and S., a little to the E., but none to the W. Six hours later more pronounced to the E. but still none to the W. Umbra appearing to protrude.

3. Nucleus large, black, and irregular, partly indented at the western edge by the influx of photospheric matter, two very small nuclei on the N. edge of the penumbra.

4. More indented to the W. A small spot f.

5. Nucleus divided, except a narrow isthmus, to the N., somewhat resembling a lintel and the two posts of a door. Many small followers.

6. A bright bridge, hooked at the end, extending across the nucleus, Mr. Wadmore describes it as seeming to stand up from the solar surface; f. spots in two clusters.

7. Three narrow bright bridges N. and S. dividing the nucleus into four parts. Two clusters of small spots f. Mr. Hadden reports that at 5.10 p.m. and 5.30 this spot and the region closely following was the centre of very active disturbance when observed with the spectroscope. At 7.10 it had nearly ceased.

8. On the central meridian, elongated and almost parallel to the equator; penumbra branching on the N. f. side. The two clusters increased and surrounded with penumbra.*

9. Major axis of large spot nearly 2′ of arc in length, or 48,000 miles, or $\frac{1}{18}$ of the solar, diameter. Whole group over 170,000 miles. Bridges singularly arched, but not entirely dividing the nucleus. F. clusters with more space between the two. The f. with many little irregular nuclei surrounding a vacant space.

10. Nucleus tapering at the eastern extremity, penumbra torn at the edges; f. spots more separated and rapidly changing.

* A drawing in the "Journal," Vol. IX., No. 2.

Sept. GROUP 66—*continued.*

11. Torn fragments of penumbra replaced by small spots. On this date Mr. Maw observed many interesting changes taking place in the nucleus, especially what he terms "veiled bridges." (*See* "Observatory," November 1898, No. 272.) F. spots again altered in form and position. Those at the rear in a semicircle.
12. Nucleus jagged and curving, with "black holes" visible in it. The f. spots decreasing, but the semicircle more pronounced.
13. Still very complex. Nucleus in two divisions.
14. Much foreshortened, penumbra spreading to the N. At 8.50 a.m. the f. spots quite distinct and rapidly decreasing in number. At 5.30 p.m. penumbra forming a singular loop, the smaller nuclei very indistinct, hardly more than one spot f. with its penumbra on the opposite (f. side) to what it was a.m.
15. At 11 a.m. two spots close to W. limb, the larger a mere line (probably the one which returned after rotation), the rearward spot with penumbra on the f. side.

Sept. GROUP 67. *Long.* 167° to 161°. *Lat.* 3° N.

11. Two small spots, observed by Mr. Hadden at 2.30 p.m.
13. A few more.
14. A curved stream, at 10.20, the first and last larger than the rest, but almost without penumbra. At 5.30 p.m. great increase, two compound spots, the intermediate almost gone. (On the meridian.)
15. Both spots nearly circular, the f. opening westward. Major axis about 30″.
16. The f. elongated, tapering to the S.W. Some outliers.
17. The p. normal; the f. broken up with no penumbra to the E.
18. The p. much reduced, the f. almost gone. No outliers.
19. One very small spot.

Sept. GROUP 68. *Long.* 174° to 169°. *Lat.* 12° S.

14. Two very small spots at 2 p.m. (not seen at 10.20 a.m.) A few more at 5.30, in two sets.
15. One spot p., a little pair f.
16. A stream, but no increase in area.
17. Many more, in two groups, hardly any penumbra.
18. The leading spot larger, with several small nuclei, fewer following.
19. Leader with two nuclei, the f. in a zigzag.
20. Tapering and broken up at the extremity. Six spots f.
21. Divided, four spots f.
22. Apparently reunited.
23. Decreasing. Two nuclei.
24. Penumbra fast disappearing. A new spot f.

Sept. GROUP 70. *Long.* 356°. *Lat.* 4° N.

23. A dot at 5 p.m. observed by Mr. Hadden.
24. A very small spot, a fainter at some distance s.p.
25. Dots only in two. (Possibly this may not be the same group.)
26. Three veiled spots.
27. Rather more conspicuous.
28. Hardly visible.

Sept. GROUP 71. *Long.* 317° to 311°. *Lat.* 11° to 13° N.

26. A single faint spot at 8.20 a.m., about 56° E. of central meridian. At 1.10 p.m. five.
27. Slightly increasing at 4.55 p.m.
28. A small penumbral spot with double nucleus. Dots streaming in front like a shower of sparks. (At 8 a.m.)
29. Immense increase in 24 hours, two considerable and very compound spots with numerous small nuclei and outliers adjacent.
30. Elongated, the two p. with penumbra on opposite sides, giving the whole a twisted appearance; rear spot normal.

GROUP 71—*continued.*

Oct.
1. Leader normal, all slowly decreasing.
2. The p. divided, the f. broken up.
3. All more reduced.
4. Two spots, the p. normal, the f. very small.

Sept. GROUP 72. *Long.* 266° to 258°. *Lat.* 6° S.
28. A penumbral spot near E. limb with a smaller one f. At 1.15 two nuclei.
29. Penumbra on the f. side.
30. The f. spot decreasing.

Oct.
1. Signs of severance.
2. Major axis 40″. The f. with divided nucleus.
3. Broken up at the extremity
4. Nucleus jagged.
5. Elongated, the f. spot without penumbra.
6. A portion to the N. severed, the f. gone. Outliers s. f.
7. On the wane.
8. Very small.
9. Still decreasing.

Sept. GROUP 73. *Long.* 240°. *Lat.* 12° S.
29. Recorded at Greenwich, on this date, but not visible at 8.20 a.m. Second return of the large September group.
30. A large spot, nucleus bridged, penumbra chiefly to the N. and S.

Oct.
1. Three distinct nuclei nearly equal in area. (*See* illustration.)
2. Somewhat quadrangular, a small penumbral spot to the N. and a few much smaller f.
3. Three distinct nuclei, major axis 1′ 30″, breadth 1′; two penumbral spots to the N. Mr. Wadmore observing by direct vision remarks that one can hardly resist the idea that the spot is a cloud formation, and that in some places one is looking through a relatively thin film of mist.
4. Nuclei more irregular, penumbra with several fissures, f. spots all very small.
5. More subdivision, penumbra expanding to the E.
6. Very complex (see illustration) bridged and broken in every direction.
7. Still more complex. Prof. Pereira reports a curious and perfect instance of a black hole, and over it a bridge. (See illustration).
8. No radical change, still bridged and fissured, penumbra less extended eastward; no f. spots.
9. Penumbra opening westward.
10. Fast decreasing; the area not half what it was on the 8th.
11. Two principal nuclei.
12. Close to limb at 11.15.

Oct. GROUP 74. *Long.* 273°. *Lat.* 10° N.
4–7. A few very small spots in a stream N. p. Group 72.

Oct. GROUP 75. *Long.* 156° to 153°. *Lat.* 11° to 12° S.
7–12. When near E. limb a group of very small spots and dots, on the 9th 14° to 15° S. By the 10th an elongated penumbral spot, major axis 40″. Broken up into a number of fragments, chiefly nuclear. On the 11th a condensed cluster. On the 14th five dots only.

Oct. GROUP 76. *Long.* 36°. *Lat.* 13° S.

18–20. A few insignificant spots.

Oct. GROUP 77. *Long.* 308° to 302°. *Lat.* 11° to 15° N.

22. A fine spot close to E. limb at 10.38. (Nearly the same position as Group 71, but long. less.
23. Very compound, in several closely contiguous sections, as if three or four spots had amalgamated; a large proportion of penumbra.
24. One principal spot; a smaller closely p. and another f.
25. No details.
26. No details.
27. At 3 p.m. much altered, the f. spot the largest of the three, the middle one being much reduced, a new one has appeared in advance.
28. More broken up, the new spot shattered. Group major axis 2′ 48″ or 75,810 miles, main spot 0·29 or 21,660 miles.
30. Decidedly reduced and elongated.
31. Dwindling.

Nov.

1. Still more reduced, the final spot quite fragmentary, the p. double.
2. One small spot only, with several dots.
3. Nearing W. limb.

Oct. GROUP 78. *Long.* 279°. *Lat.* 7° N.

26. A penumbral spot some distance from E. limb.
27. Two nuclei, a little irregular stream f.
28. No details.
30. Normal, solitary. 31 nebulous.

Nov.

1. Two nuclei. 2. Little change, only slight penumbra. 3 much reduced.
4. Small and faint.

Oct. GROUP 79. *Long.* 240°. *Lat.* 13° S.

28. A small spot near E. limb. (Recorded at Greenwich on the 27th.) (A third return of the large spot of Sept.)
30. Not more than 30″ in major axis, some scattered outliers chiefly f.
31. Leader with a portion on the f. side, as if severed, outliers fewer.

Nov.

1. Only two outliers.
2. A scattered group of small spots.
3. Much decreased; nebulous, a similar spot 6° more S. in nearly the same long.
4. The southern spot faint.
5. Both decreasing.
6. Still on the wane; southern spot gone.
7. Only just visible.

Oct. GROUP 80. *Long.* 209° to 199°. *Lat.* 4° to 8° N.

31. A few spots near E. limb hardly perceptible, observed by Mr. Bartlett at 9.15, but not seen by Miss Brown at 8.10.

Nov.

1. Great increase, the leader A, compound, major axis 45″. The f. B, consisting of a few small spots.
2. A, with several irregular small nuclei. B, a compact cluster of fairly large spots with slight penumbra.
3. Both about 50″ in major axis, with many small nuclei and still very irregular.

Nov. GROUP 80—*continued.*

4. Still increasing, A more regular but splitting across the centre, B with as many as seven principal nuclei.
5. On central meridian, A more subdivided, B breaking up.
6. Both expanding, an opening in centre of A, B closing up, with a large proportion of penumbra. Little spots in a row f. touching each other; many outliers.
7. Nucleus of A larger, especially the p. B a mass of fragments, major axis of A about 1′ 20″ of arc.
8. No details.
9. More normal but bridged, faculæ clinging to spot.
10. Two nuclei, faculæ more extensive.

Nov. GROUP 81. *Long.* 173° to 166°. *Lat.* 9° to 10° S.

1–9. One little spot. On 3rd, a cluster of very small spots which increased slightly in area, and formed two sets of spots by the 5th. On the 7th they formed a stream all with penumbra, and on the 9th were still visible though very faint.

Nov. GROUP 82. *Long.* 168° to 161°. *Lat.* 4° to 6° N.

5–13. A few spots in two compact little clusters, which formed a pair by the 6th; were normal on the 7th; the following spot breaking up on the 8th, only one small spot of the following portion remaining on the 11th.

Nov. GROUP 82A. *Long.* 178°. *Lat.* 17° S.

10. A small isolated spot.

Nov. GROUP 83. *Long.* 84° to 80°. *Lat.* 7° S.

11–16. Two little spots which have slight penumbra on following side, and some outliers on the 13th. On the 14th the spots are in a line, but little inclined to the equator, all without penumbra. On the 16th only three were visible.

Nov. GROUP 84. *Long.* 356°. *Lat.* 13° S.

18–26. A nuclear spot with axis not exceeding 20″, followed by a few small ones, in a stream on the 19th, reduced to one on the 22nd, and wholly disappeared when leader near limb on the 26th.

Nov. GROUP 85. *Long.* 213° to 209°. *Lat.* 5° N.

29-30. Two little spots widely separated, a cluster on the 30th. A return of Group 80.

Nov. 27–Dec. 8. GROUP 86. *Long.* 203°. *Lat.* 8° S. Appeared as a penumbral spot near limb amid compact faculæ. On Nov. 29, normal, major axis 45″. On 30th a few faint outliers. On December 3rd was divided, and formed a close pair equal in area on the 4th, on the 7th was decreasing, and was much reduced by the 8th.

Dec. GROUP 87. *Long.* 131°. *Lat.* 13° S.

2–13. A spot 1′ of arc in major axis, which is nearly normal, but with an elongated nucleus by the 4th. On the 7th it began to be severed into two parts, the process being completed by the 8th. On the 9th it was changing rapidly, but was more condensed, composed of nuclei, with tongues and bridges. On the 10th the two portions were just joined by a penumbral thread. On the 11th was still more compact, with three nuclei, but again was severed when, much reduced, was nearing the limb.

Dec. GROUP 88. *Long.* 289°. *Lat.* 7° N.
19–20. A scattered group of small spots.

Dec. GROUP 89. *Long.* 180° to 182°. *Lat.* 11° S.
28–31. Two faint spots, widely separated; on the 30th four; on the 31st, much developed in two sets.

Dec. GROUP 90. *Long.* 155°. *Lat.* 13° S.
29–30. A very small spot among bright faculæ.

Dec. GROUP 91. *Long.* 111°. *Lat.* 5° S.
31. A spot near E. limb with slight penumbra.

Published February 20, 1900.

1898. Second and Third Appearance of Great September Group.

Sep. 3. H. Corder, del.

Sep. 7. 12. 50. T. H. Astbury, del.

Sep. 8. 12. 55. T. H. Astbury, del.

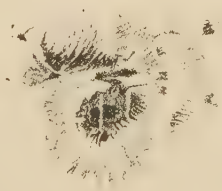
1898. Second and Third Appearance of Great September Group.

Sep. 11. 1.5. T. H. Astbury, del.

Sep. 12. 1.0 T. H. Astbury, del.

Oct. 1. H. Corder, del.

Oct. 11. J. de M. Pereira, del.



Oct. 6. J. de M. Pereira, del.

Tailby & Price, lith.

SECTION FOR
ASTRONOMICAL PHOTOGRAPHY.

DIRECTORS { JOSEPH LUNT, F.R.A.S., B.Sc.
R. WILDING, F.R.A.S.

REPORT OF THE SECTION, 1897-98.

Judged by the number of Members who expressed a willingness to co-operate in the work, the Section gave early promise of being a successful one. The Directors have, however, to confess to a feeling of disappointment that many have gone no further than this initial step, and have not as yet furnished samples of their work. Others apparently are still engaged in preliminary experiments with a view to making their equipment more perfect before commencing systematic work.

Those Members who so kindly undertook to do printing, enlarging, lantern-slide making, and the thorough examination and comparison of negatives, with a view to relieving those of the night workers who have limited leisure for such work, have not been kept so busy as the Directors had hoped.

In solar photography Mr. Newbegin deserves special mention as having given us a more or less continuous record of the telescopic appearance of the sun's surface, only broken by his disinterestedness in lending his admirable instrument for the purpose of eclipse observations in India.

His photographs have been exhibited on the screen from time to time at our monthly meetings as interesting solar disturbances manifested themselves, and they are so well known and appreciated by the Members that no further description of them is needed.

Dr. Smart has, from time to time, contributed photographs of individual sun-spot groups on a larger scale and has furnished us with additional detail to that shown on Mr. Newbegin's photographs.

In lunar photography, Mr. Offord, assisted by Mr. Dykes, has done good systematic work. He has given his results in the form of a paper published in our "Journal."

In planetary photography, Mr. Longbottom and Mr. Offord have made some interesting experiments, but the day for successful planetary photography has yet to come, and visual observations remain *facile princeps* in this class of work.

In stellar and nebular photography Messrs. Ellis, Longbottom, and Evans, and Prof. Naegamvala have given us valuable records, to which the Directors have added their quota. The Directors

record with very deep regret the loss the Section has sustained by the untimely and sudden death of Mr. J. de Villiers, who was killed in the lamentable railway accident at Mosterthock, South Africa, on August 16, 1898.

Mr. de Villiers purposed devoting himself to astronomical pursuits in his retirement at Sea Point, and had erected an observatory which must be regarded as on a magnificent scale for an amateur. The building was completed, and the transit instrument and photographic equatoreal were all but finished ready for shipment to the Cape, when he was so suddenly taken from us.

His death is the more to be regretted as his sphere of work would have been the southern skies, and no doubt, had he lived, the Members would have had good opportunities of seeing portrayed on the screen some of the wonders of the heavens which northern observers may never see.

List of Members and Contributors.

Names.	Locality.	Instrument.
Allen, A. C.	Folkestone	$3\frac{1}{2}$-in. refractor.
Antoniadi, E. M.	Juvisy, near Paris	——
Bacon, Rev. J.	Newbury	12-in. reflector, $4\frac{1}{10}$-in. refractor.
Bacon, Miss Gertrude	Newbury	12-in. reflector, $4\frac{1}{10}$-in. refractor.
Clapton, T., F.R.P.S.	Harlesden, N.W.	——
Clough, Chas. E.	Southport	$9\frac{1}{4}$-in. reflector, $3\frac{1}{2}$-in. P.L.*
Dykes, F. J.	Ealing	——
Ellis, H.	Potter's Bar	9-in. reflector, 80-in. focus.
Evans, F.	Chester	6-in. refractor, $5\frac{1}{2}$-in portrait lens.
Eversbed, J.	Kenley, Surrey	$2\frac{1}{4}$-in. Prismatic camera.
Forsyth, H. C. B.	Macduff, N.B.	3-in. altazimuth refractor; $1\frac{1}{2}$-in. lantern lens.
Freeman, A.	Hastings	$10\frac{1}{4}$-in. reflector, 2-in. guider.
London, W.	Woodbridge	$15\frac{1}{2}$-in. reflector.
Longbottom, F. W.	Chester	$18\frac{1}{2}$-in. reflector (altazimuth). 3-in. refractor, $2\frac{1}{2}$ in. and $5\frac{1}{2}$-in. P.L.
Lunt, J.	Cape of Good Hope	——
Maunder, E. W.	Lewisham, S.E.	——
Maunder, Mrs.	,,	——
Maw, W. H.	Kensington, W. and Outwood, Surrey.	6-in. and 8-in. refractors, 8-in. single lens, $4\frac{1}{2}$-in. P.L.
Moore, J.	Charlton	9-in. refractor.
Naegamvala, Prof. K. D.	Poona, India	$16\frac{1}{2}$-in. reflector.
Newbegin, G. J.	Norwich	9-in. and 4-in. refractors, 2-in. P.L.
Offord, J. M., F.R.M.S.	Ealing	$12\frac{1}{4}$in. reflector, $3\frac{3}{4}$-in. refractor.
Smart, Dr. D.	London, S.E.	10-in. reflector.
Wilding, R.	Bartle, near Preston.	19-in. reflector, 5-in. P.L.

* P. L. = Portrait Lens.

I.—The Sun.

Messrs. Maunder, Newbegin, Smart, and Allen have contributed photographs of the solar disk and special sun-spot groups. Mr. Newbegin has contributed by far the largest number of these, which form an admirable series. Dr. Smart has furnished 25 photographs, and Mr. A. C. Allen two experimental ones.

II.—The Moon.

Messrs. Offord, Longbottom, Newbegin, and Wilding have furnished more or less successful photographs of the surface of our satellite. Mr. Offord being *facile princeps* in this work, and having obtained most encouraging results considering that his are amateur efforts with amateur equipment.

Messrs. Smart, Moore, and Freeman have also contributed their experimental results in this field.

The more noteworthy of Mr. Offord's* photographs are given below. For further details of his equipment and methods *see* his paper "Journal of the British Astronomical Association," Vol. VIII., No. 5, p. 232).

Region.	Date.	Time.
	1896.	h m
Theophilus - - -	Aug. 27	11 45
Theophilus (smaller scale) -	„	11 30
	1897.	
Full moon - - -	Feb. 17	9 15
Gassendi - - -	Mar. 15	?
Aristarchus (showing also the Moon maiden).	„	10 20
Straight wall - - -	April 10	8 45
Plato Lunar Alps and Archimedes.	„	9 58

* Mr. Offord was often assisted by Mr. Dykes.

III.—The Lunar Eclipse of January 7, 1898.

Messrs. Longbottom and Smart are the only Members who have sent photographic records of this phenomenon.

Mr. Longbottom made 10 exposures with his 18½-inch Calver reflector, giving exposures of $\frac{1}{10}$th second with a stationery telescope. The focal length of his instrument is 10 feet 5 inches, and the scale of his photographs is nearly 2¼ inches to the lunar diameter. A print of one of these, taken at $11^h\ 52^m$, and sent with his return, is full of fine detail, and makes a capital record of the partial phase.

Dr. Smart's four photographs are an inch smaller in diameter, and not so successful as the last named.

IV.—The Planets.

This field of work is certainly the most difficult and least profitable of any which the Members can take up. Even large well equipped observatories have not been able as yet to turn out photographs which, as regards planetary detail, are worthy the time and pains bestowed upon them, and therefore amateurs with small equipment should be discouraged from attempting work in this field. The time expended could be more profitably occupied with stars and nebulæ, unless, indeed, some of our more ambitious Members turn their attention to the photographic search for faint undiscovered satellites, and even this is a field where the large observatories are more than likely to anticipate the efforts of our Members.

Messrs. Offord and Longbottom are the only Members who have attempted planetary work. Venus, Jupiter, and Saturn have each received a share of attention.

V.—Comets.

We have not been favoured by the appearance of any bright comet. Through the kindness of Her Majesty's Astronomer at the Cape of Good Hope, one of the Directors of the Section is able to contribute his photograph of Comet Coddington, taken with the 13-in. astrographic telescope with an exposure of two hours. It appears merely as a small nebulous ball with a suspicion of a short fan-like tail or an eccentric condensation.

The photograph is useful merely as showing how the Members of this section may secure fairly accurate positions for objects of this class by submitting their photographs to careful measurement. The two ends of each star trail represent the relative positions of the neighbouring stars and the comet at the commencement and end of the exposure.

One can make a paper print from the negative; place a piece of paper underneath it and prick one end of all the trails and the nucleus of the comet with a fine needle, and so obtain *diagrams* of the position of the comet with respect to the stars in the same field. Of course the centre of the nucleus of the comet must be used for guiding and not the stars, which latter must be allowed to trail as the comet moves along amongst them.

Those Members possessed of large reflectors are recommended to attempt any comet which is bright enough to show up the wires of their guiding telescopes, and so allow of guiding with dark wires on the brighter background given by the nucleus.

VI.—Meteors.

Bad weather prevailed in England during the November meteor period, and no photographs have come to hand. Judged by the display at the Cape, where clear cloudless skies were vouched to us, the shower was a very poor one, and in no way came up to expectations.

Through the kindness of Her Majesty's Astronomer at the Cape, a copy of a chance meteor caught on one of the chart plates of the International Survey, by Mr. C. Ray Woods, during the routine work, is included in our collection.

Chance meteors like this are by no means rare, and should be looked for on all negatives, and not confused with chance scratches.

VII.—Star Fields, Clusters, and Nebulæ.

This branch of work is one of the most fascinating and promising. The Members have secured a good number of negatives, many of them of excellent quality.

Messrs. Longbottom and Evans, Ellis, Naegamvala, and the Directors are the only ones who have made really serious efforts, The Directors regret that various circumstances have combined to make the first beginnings of this work rather tardy. There are still many instruments adapted for the work which, up to the present, have not been fully utilised by our Members for, no doubt, excellent reasons; but it is hoped that these may soon be pressed into the service, and that the preliminary experimental stage may soon give way to more constant and systematic efforts.

The English climate is by no means conducive to sustained regular work in this branch of astronomical photography. Who that has worked in it has not again and again adjusted his instrument and made every preparation for a good night's work, only to feel the keen disappointment of having to relinquish it on account of thick haze or denser clouds coming up to mar the clear sky which tempted him on during his preparations. Perhaps a short exposure has already been secured on an object requiring a long one when the "cease fire" has to be sounded to dodge a sudden rain squall. High winds and the dewing of object glasses account for still further wasted efforts. Whilst others have experienced the exasperating presence of beautifully clear and suitable skies on occasions when other more pressing engagements have called them elsewhere to leave their telescopes idle.

These factors apply of course to all branches of astronomical observation, but owing to the much longer time taken up in preparing an instrument for photographic work they apply most of all to those engaged in securing photographic records.

For the encouragement of those who are not possessed of driving clocks to their telescopes, Mr. Longbottom's hand-driven photographs are especially commended. His photographs were taken with a 3-in. Cooke equatoreal on a portable stand, which had to be carried in and out for each night's work, and his camera was only furnished with a Dallmeyer portrait lens of $2\frac{5}{8}$-in. aperture and $6\frac{1}{4}$-in. focus. The instrument was kept moving during the whole exposure by means of a hand slow-motion rod.

His photographs show an astonishing number or stars and great wealth of detail, and the driving is really admirable.

His longest exposures were an hour and a half, which he says is all he is capable of at one sitting, and those who have tried it will readily endorse his opinion.

His results have been sufficient to encourage him to erect a solid equatoreal with a driving-clock, on which he has erected a 5½-in. Voigtlander portrait lens of 22½-in. focus. No doubt he will find this far less fatiguing, and we shall expect him to give us much longer exposures in future in consequence.

Mr. H. C. B. Forsyth, Macduff, N.B., has attempted an even more difficult feat, viz., stellar photography with an altazimuth! He has forwarded a print from one of his negatives of the constellation of Orion taken by means of a 1½-in. lantern lens, mounted on a 3-in. altazimuth refractor. Exposure 22 minutes. His enthusiasm is worthy a better equipment.

Hints to Members.

The following hints may be of use to those Members who are making their first experiments in astronomical photography, and as some may not be experienced photographers, some details of photographic procedure are added.

(1.) *Focussing.*—Never attempt to ascertain the best working focus of your object-glass by viewing a star image on a ground-glass screen.

Devote a whole night, or several nights if necessary, to this fundamental point, and make all your focussing experiments photographically.

Fix a scale on your instrument so that you can read changes of distance between lens and plate.

Having ascertained the approximate focus in the daytime by focussing a very distant object on the focussing screen, move the plate well within this point and expose a plate on the night sky in a region where there are a few bright stars.

Allow the camera to remain stationary and let a star image trail along the plate for some definite length of time, say, 2–5 min. Move the camera forward in R.A. until the star is seen in its original position in the guiding telescope, then move slightly in Dec^{n} and re-expose, say, at 5 mm. longer focus. Repeat the operation until 5 or 6 exposures have been made at plate distance intervals of 5 mm., and all at regularly increasing or diminishing Dec^{n} readings.

Let the last exposure be twice as long as the others in order that the longer trail will enable you to identify each exposure.

It will probably be found that the sharpest line is at a focus somewhere between the extreme readings.

If not, repeat the operation until it is.

This will give an approximate focus. Repeat the operation on another plate, changing the plate distance by single millimètres, this time, starting just within and ending just without the best focus found in the first trial. With longer focus instruments finally expose another plate about the best focus for the centre of the plate, changing the focus reading by half millimètres until the sharpest line is obtained. The separation of the two trails

of some convenient double star is a good test of relative sharpness for the finer focussing.

Now expose on stars, with the clock driving the telescope, at three or four focus readings close to the best focus found from the trails, changing the Dec^{n} for the second and third, and the R.A. an equal angular distance for the fourth exposure.

The best all round results will, in most cases, be obtained by making a slight sacrifice of absolute sharpness at the centre of the plate in order to obtain a fair average sharpness over a larger area. The sharpest stars will then lie in a circular zone round the centre of the plate. Judgment must be used as to how much to sacrifice in the centre. The sacrifice should not be apparent at a glance, or it is overdone.

Area of good definition.—Above all things do not let your anxiety to include a large area lead you to produce a negative looking more like a photograph of a whirlpool than anything else. Nothing looks worse than a crowd of stars apparently racing round the outer regions of your picture. Place a circular or square diaphragm in front of your plate, to cut off all such objectionably distorted images (or mask out when reproducing) even if your photograph only covers a half-a-crown, and show all your photographs as enlargements from the original.

Keep a watchful eye that the sharpest region of your photographs remains where it was intended to be, and correct for seasonal changes of temperature, if necessary.

Backed plates.—Always use backed plates for long exposures or for regions containing bright stars. Plate-makers now supply plates ready backed. These save trouble. This is especially important for solar and lunar photographs. Unbacked plates give less crisp definition owing to halation. This is seen in solar photographs as a hazy ring round the sun's limb. The haze is really overspreading the whole photograph and masking contrasts. In stellar negatives the brighter stars show spurious ring nebulæ surrounding the images. These can be effectively got rid of by proper backing.

Guiding.—The best of clocks are not to be trusted for long. Constant watchfulness is required to keep the star image from straying off the guiding wires.

Flexure of the instrument.—Reflectors are especially liable to this, and long exposures should not be attempted without some means of correcting it.

The plan adopted by Mr. W. E. Wilson, of Darramona, Ireland, is an excellent one, and avoids piercing the centre of the large mirror. The slide of the plate holder is silvered on the side facing the mirror, and can be illuminated by red light. The plate is closed at intervals, the slide being pushed home to a stop. The star image is then viewed by a small telescope, and any straying of the image from the cross lines on the silvered surface can be detected and at once corrected.

The best place for the plate is in the centre of the tube, and not, by the use of a flat, at the side, unless an enlarging lens is employed.

In developing your plate, do not let your anxiety to see what is coming out tempt you to flood the plate with an unnecessary amount of red light, which may not be so safe as you imagine. This will cause fogging, and spoil your negative.

Manipulate your plate before exposure in absolute darkness, if possible, and thoroughly test your dark-room illumination to see that an exposure of, say, 5 or 10 minutes to the light of your developing room causes no fog to appear on a test plate. Make sure that your telescopic camera is light tight. Time your development rather than *see* its progress, and only use a faint safe light momentarily towards the middle and end of development to make sure that no fogging is taking place.

Development.—There is no *best* developer. After becoming accustomed to use a particular developer which gives good clear plates, free from stain or fog, do not lightly discard it for a newer one, without careful comparative experiments.

The following is a good developer for star plates :—

Stock Solutions—

(*a.*) 1 oz. hydroquinone, 1 oz. eikonogen, add 20 ozs. of 20 per cent. sodium sulphite solution, and pour into 20 ozs. of hot water. Stir until all is dissolved, and keep in well-stoppered bottles.

(*b.*) $2\frac{1}{2}$ ozs. 20 per cent. sodium carbonate solution (made from the crystalline salt), $2\frac{1}{2}$ ozs. 20 per cent. potassium carbonate, add 15 ozs. water.

(*c.*) 10 per cent. potassium bromide solution. In use take 2 ozs. each of (*a*) and (*b*), add 4 ozs. of water and 20 minims of (*c*).

Always use freshly mixed developer, and renew your hypo-sulphite bath when it becomes stained.

In hot weather, or in hot climates, use an alum bath after the developer, but wash the plate well after alum and before fixing.

LIST OF PHOTOGRAPHS RECEIVED.

List of Photographs received.

Object.	Date.	Exposure Commenced.	Duration. Sidereal Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Cluster M 46, and Nebula Herschel IV., 39 Argûs.	1894, Feb. 24	6 2	1 30	Dr. Isaac Roberts, F.R.S.	Crowborough	—	20-in. reflector	"Knowledge," Aug. 1895, p. 182.
Spiral Nebula, M 74 Piscium.	1893, Dec. 9	1 7	3 40	,,	,,	—	,,	Sept. 1895, p. 207.
Elliptical Nebula, H I. 84 Comæ Berenicis.	1894, May 7	12 31	1 30	,,	,,	—	,,	,, ,,
Elliptical Nebula, M 65 Leonis.	,, Feb. 28	8 19	0 40	,,	,,	—	,,	,, ,,
Spiral Nebula, M 66 Leonis.	,, ,,	,,	,,	,,	,,	—	,,	,, ,,
Cluster, M 13 Herculis -	1895, June 15	16 42	0 5	,,	,,	—	,,	Oct. 1895, p. 232.
,, ,, -	,, May 28	14 51	1 0	,,	,,	—	,,	,, ,,
Nebula M 78, and H IV. 36 Orionis.	1894, Jan. 28	3 3	3 0	,,	,,	—	,,	Nov. 1895, p. 254.
Nebula near 15 Monocerotis.	1895, Feb. 13	4 20	,,	,,	,,	—	,,	Feb. 1896, p. 38.
Spiral Nebula, M 33 Trianguli.	,, Nov. 14	—	2 15	,,	,,	—	Cooke 5-in. lens	July 1896, p. 158.
Exterior Nebulosities surrounding the Pleiades.	1893, Dec. 6 and 8.	—	10 15	Prof. E. E. Barnard.	Lick Observatory, California.	—	Willard lens, 6-in. aperture.	"Knowledge," Dec. 1895, p. 281.

Nebulosity round 15 Monocerotis.	1894, Feb. 1	—	3 0	,,	,,	—	,,	May 1896, p. 109.
Nebulosities near Antares and ν Scorpii.	1895, June 21–22.	—	7 30	,,	,,	—	,,	Sept. 1896, p. 205.
Nebula M 8 in Sagittarius	,, May 18–19.	–	2 40	Prof. K. D. Naegamvala.	Poona, India.	—	$16\frac{1}{2}$-in. reflector	*Aug. 1896, p. 183.
Great Nebula in Orion -	—	—	—	,,	,,	—	—	*See* "Nature," June 17, 1897, p. 153.
M 46 Cluster, and Nebula Herschel IV. 39 Argûs.	—	—	—	,,	,,	—	—	——
M 22 in Sagittarius -	—	—	—	,,	,,	—	—	——
M 46 and H VIII. 38 Argo.								
δ Canis Majoris region -								
Milky Way in Ophiuchi	—	—	—	,,	,,	—	Small portrait lens.	No details received.
M 8 region, 2 overlapping fields.								
M 67 in Cancer - -								
Pleiades - - -	1896, Nov.	—	1 0	Henry Ellis	Potters Bar	—	9-in. Reflector 80-in. Focus.	
Great Cluster in Perseus -	1897, Sept. 26	—	1 0	,,	,,	—	,,	
Orion Nebula - -	—	—	1 20	,,	,,	—	,,	
Praesepe - - -	1898, Mar. 11	—	0 35	,,	,,	—	—	
,, - - -	,, ,, 13	—	1 45	,,	,,	—	—	

* The photograph appearing in "Knowledge" is so reproduced that the wonderful detail of the original negative is altogether lost. Mr. Lunt made copies from the original negative in which the faint nebulosities are strongly brought out. For a description of the method employed *see* "Journal" British Astronomical Association, Vol. VII., No. 3, p. 132. The photograph of the Orion nebula was similarly treated.

List of Photographs Received—*continued.*

Object.	Date.	Exposure Commenced.	Duration. Siderial Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Gap in Milky Way in Serpens.	1898, Aug.	—	1 20	Henry Ellis	Potters Bar	—	—	
M. 13 in Hercules -	„ „	—	1 40	„	„	—	—	
M. 11 - - -	—	—	2 0	„	„	—	—	
Constellation of Orion -	—	—	0 22	H. C. B. Forsyth	Macduff, N.B.	3-in. Refractor Altazimuth.	$1\frac{1}{2}$-in. Lantern lens.	Hand-guiding with altazimuth.
Orion's Belt and Nebula -	1897, Jan. 24	—	1 0	Messrs. Evans and Longbottom	Chester	6-in. Refractor	$5\frac{1}{2}$-in. Portrait lens.	
Region of γ Cassiopeiæ -	„ Feb. 27	—	2 0	„	„	„	$2\frac{1}{2}$-in. „ „	
ζ Serpentis region -	—	—	0 18	„	„	„	„ „ „	
α Serpentis region - -	—	—	0 30	„	„	„	„ „ „	
Coma Berenices - -	„ Apr. 30	—	0 25	F. W. Longbottom.	„	3-in. Refractor	$2\frac{5}{8}$-in. „ „	Hand-driving.
Region of ϵ Virginis -	„ May 3	10 10	0 40	„	„	„	„ „ „	„ „
Milky Way round χ Cygni.	„ Aug. 27	10 0	1 0	„	„	„	„ „ „	„ „

Great Nebula in Andromeda region.	„	Dec. 15	6 50	0 41	„	„	„	„ „ „	„ „
Pleiades - - -	—		—	1 30	G. J. Newbegin	Norwich	9-in. Refractor	2-in. Dallmeyer P.L. 7 in. focus.	Clock-driven.
Region of β and γ Ursæ Minoris.	„	Apr. 30	11 30	2 30	R. Wilding	Nr. Preston	6-in. Refractor	5-in. Portrait ens.	„ „
Orion Nebula - -	„	Mar. 23	—	1 55	„	„	„	19-in. Reflector	
ζ Orionis - - -	„	„ 25	—	3 0	„	„	„	„	7 patches of Nebula and 3 Nebulous stars.
Orion Nebula - -	„	Dec. 20	—	0 50	„	„	„	„	
Region of γ Cygni - -	„	Aug. 28	10 0	2 0	„	„	„	5-in. Portrait lens 26-in. focus.	
Pleiades - - -	„	Dec. 21	—	3 50	„	„	„	„	
γ Cassiopeiæ - -	„	Nov.	—	1 0	„	„	„	„	
„ - -	„	„	—	2 30	„	„	„	„	
β Andromedæ - -	„	„	—	2 0	„	„	„	„	
Orion's belt and Nebula -	„	Jan.	—	2 0	„	„	„	„	} Several well-marked Nebulæ.
ζ Orionis - - -	„	Feb.	—	2 30	„	„	„	„	
Praesepe - - -	„	Mar. 20	—	2 0	„	„	„	„	
Coma Berenices - -	„	„ 21	—	2 0	„	„	„	„	7 Nebulæ shown.

Photographs of Telescopes and Observatories.

Mr. Wilding's -	Observatory -	Bartle, nr. Preston.	Exterior.
„ - -	„ -	„ -	Interior.
Mr. Offord's - -	Reflector - -	"Run off" Hut, Ealing.	——
Mr. Evans' - -	Observatory -	Chester -	Exterior.
The late Mr. J. de Villiers'.	Observatory -	Sea Point, South Africa.	„
Dr. Smart's - -	Reflector and camera.	London -	——
„ - -	Camera detached	„ - -	——

Miss Gertrude Bacon, and Messrs. London and Clapton, have kindly undertaken to carry out printing, lantern slide making, enlarging and reducing from Members' negatives in cases where they have not the requisite leisure or appliances for the purpose. By some who have only the bare leisure for the actual night observing this kind offer will be much appreciated.

The Directors hope that this small beginning will mark the commencement of a prosperous and productive section in the near future, and that all the Members will quickly surmount their initial experimental difficulties and settle down to more regular work, and so give scope for more systematised efforts than can at present be put forth.

JOSEPH LUNT
R. WILDING } Directors.

SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—ARTHUR COTTAM, F.R.A.S.

EIGHTH REPORT OF THE SECTION.

REPORT OF THE APPARITION OF 1898 AND 1899.

PART 1.

INTRODUCTORY.

I have followed the plan adopted by my predecessor, of dividing this Memoir into five Parts. Part 1 is a general introduction; Part 2 a general account of disk observations; Part 3 includes notes upon, and tabular statements of, observations of transits of spots, &c.; Part 4 contains satellite observations; and Part 5 contains various observations made with reference to the colours and colour changes on the Planet during the apparition.

The following is a list of the Members of the Section up to date, with the usual particulars

Name.	Locality.	No. of Drawings.	Instrument.
WM. ANDERSON, F.R.A.S.	Madeira	3	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	—	—
E. ATTKINS	Highgate	25	6·5 in spec.
E. G. AYLETT	Bredgar	—	—
Rev. J. BAIKIE, F.R.A.S.	Ancrum	—	—
G. BANASTER, F.R.A.S.	Tewkesbury	—	—
W. M. BAXTER	Edinburgh	—	—
SCRIVEN BOLTON	Leeds	3	$4\frac{1}{2}$-in. O.G.
LEO BRENNER	Lussinpiccolo	—	—
J. H. BRIDGER, Mus.B.	Farnborough	3	4-in. O.G.

Name.	Locality.	No. of Drawings.	Instrument.
G. L. BROWN	Stirling	—	—
R. W. BUTTEMER	Godalming	—	—
B. E. CAMMELL, F.R.A.S.	Wokingham	—	—
H. Y. CHILDS	Portland	—	—
J. E. CLARK, B.A., B.Sc.	York	—	—
E. J. COPE	Malvern	—	—
H. CORDER	Bridgwater	—	—
ARTHUR COTTAM, F.R.A.S.	Watford	2	$12\frac{1}{2}$-in. spec.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—	—
R. CROSS	Oxford	—	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	—	—
HY. ELLIS, F.R.A.S.	Potter's Bar	—	—
E. ESSAM, F.R.A.S.	Billingboro'	—	—
J. EVERSHED, F.R.A.S.	Kenley	—	—
R. FALCON	Workington	—	—
Rev. T. H. FOULKES, M.A.	Malta	3 parts	$10\frac{1}{2}$-in. spec.
A. FREEMAN	Hastings	—	—
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	—	—
F. J. GARRARD	Louth	—	—
W. GOODACRE, F.R.A.S.	Crouch End	—	—
H. F. GRIFFITHS	Streatham	—	—
ED. HALL	Bjorneburg	—	—
W. J. HALL	Nantwich	2	$4\frac{7}{8}$-in. spec.
G. B. P. HALLOWES, F.R.A.S.	York	—	—
A. HENDERSON	Liverpool	—	—
E. R. HICKS	Kensington	—	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—	—
W. H. IZZARD	Brentford	—	—
J. JACKSON	Blackpool	—	—
W. E. JACKSON, F.R.A.S.	Liverpool	—	—
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	—	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	—	—
Rev. R. KILLIP, F.R.A.S.	St. Annes-on-Sea	9	5-in. O.G.
N. LATTEY	Cardiff	—	—
J. LUNT, B.Sc.	Ealing	—	—
HY. MACEWEN, F.R.A.S.	Glasgow	—	—
W. H. MAW, F.R.A.S.	Kensington	—	—
J. W. MEARES, F.R.A.S.	Calcutta	—	—
A. MEE, F.R.A.S.	Cardiff	—	—
F. K. MELLOR, F.R.A.S.	Huddersfield	—	—
Capt. P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	2	$12\frac{1}{2}$-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	—	—
J. ORR	Glasgow	—	—
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—	—
Dr. G. PATTERSON, M.A.	Ascot	—	—
Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.	Yeovil	4	9-in. spec.
J. PHILLIPS	Hereford	—	—
W. T. PRIDE	Wellington	—	—
Rev. V. REID	Glasgow	—	—
C. ROBERTS, F.R.A.S.	Kensington	—	—
Dr. RYLE, M.A.	Brighton	4	$2\frac{1}{10}$-in. O.G.

Name.	Locality.	No. of Drawings.	Instruments.
W. C. STEWART	Clapton	—	—
Dr. SMART, F.R.A.S.	Bermondsey	1	10-in. spec.
C. F. SMITH	Edinburgh	10	5¼-in. spec.
H. F. SMITH	Luton	—	—
Rev. W. SWINDLEHURST	Wickham, N.S.W.	—	—
C. A. TAYLOR	London	—	—
H. J. TOWNSHEND	Leeds	9	10-in. spec.
J. M. WADMORE	Exmouth	—	—
Rev. W. R. WAUGH, F.R.A.S.	Portland	1	4·5-in. O.G.
Rev. L. A. WILLIAMS	New Shoreham	—	—
A. STANLEY WILLIAMS, F.R.A.S.	Brighton	—	—
H. WRIGHT	Sidney, N.S.W.	3	8½-in. spec.
J. WYKES	Birmingham	—	—

Mr. Scriven Bolton, of Leeds, and Mr. F. J. Garrard, of Louth, have recently joined the Section. The former has contributed three drawings for the present Report.

The adopted nomenclature diagram has been inserted in the previous reports, and as the Members of the Section no doubt possess some, if not all, of the earlier reports, it appears unnecessary to insert it again in this.

Mr. Crommelin's Jupiter Tables published in the "Monthly Notices" of the Royal Astronomical Society are of great value to our Members.

The total number of drawings sent to the Director has been, from observers in Britain, 73, and from observers in other parts of the world 11, making a total of 84. Five further drawings were sent by Capt. Molesworth, but not for retention of the Association, and they have been returned to him.

PART 2.

It is hoped that the following condensed description of the principal features and characteristics of the markings on the planet, with the descriptions of the drawings representing the various sections, comprising 60° of longitude in each, will, with the drawings reproduced, sufficiently indicate the appearance of the planet during the apparition of 1898–99.

1. The equatorial zone has been brightly coloured, yellowish orange being the colour most frequently noted, and the narrow equatorial belt has been very frequently and easily visible during this apparition. Another feature that has been strongly marked has been the wisps crossing the zone between the two equatorial belts, which have been much more easily seen than is usually the

case. Mr. Killip remarks that he does not remember ever to have noticed them so readily, their striking visibility appearing to him a remarkable feature of this apparition. The belt and wisps were specially visible during May and the early part of June, and are shown on numerous drawings by Capt. Molesworth, Messrs. Phillips, Killip, Attkins, and Townshend.

2. The S. equatorial belt has been the most strongly marked feature of the Planet, usually red, often a chocolate red, or mahogany colour. The belt continues broadly double, but the narrow light rift dividing it into two portions has not been so continuous as last year. The S. edge of the belt has been dark and uniform, and the two shoulders of the red spot bay have been the only marked points. There have been numerous dark spots on the scalloped northern edge, often in juxtaposition with the brilliant white spots on the southern edge of the equatorial zone. The Great Red Spot is still a pale grey, and but rarely clearly visible.

3. The N. equatorial belt has been broader than last year, nearly if not quite as broad as the S. equatorial belt, and full of interesting detail. The estimation of its colour has varied considerably. Capt. Molesworth, at Trincomali, describes it as purplish grey rather ruddier than the S. equatorial belt. Observers in England have noticed it as greenish grey, but a few represent it as reddish. On the N. edge of the belt there has been a series of white notches, and white spots of a similar character on the belt itself. Most of the drawings show these markings.

4. The S. temperate band has not been a conspicuous feature. It is shown on almost all the drawings as a straight line merely.

5. The N. temperate band has been exceedingly faint, and it is not shown at all on many of the drawings.

6. The two tropical zones have both been well marked, white, but the southern zone decidedly the whiter, but the light spots less numerous and not so distinct as last year.

7. The N.N. and S.S. temperate bands have been very faint. They are shown on Capt. Molesworth's drawings, but on hardly any others.

8. The two polar regions have been featureless, but different in colour, the southern brownish, the northern a bluish grey.

The entire date range of the drawings is from February 26 to June 16, 1899.

The general descriptions have been divided, as heretofore, into six sections, each embracing 60° of longitude.

Section I., longitude 0° *to* 60°.—There are 20 drawings in this section, the greater part of which are comparable. The red spot bay is shown in all, and in every case the following shoulder is darker. The spot itself is shown in three drawings only. Messrs. Molesworth and Phillips in one drawing each represent

it as a grey colour, but the Rev. T. H. Foulkes, at Madeira, sends a drawing of it, and describes the colour as a "very faint washed-out red." The S. equatorial belt is shown as duplex in the portion preceding the bay in six drawings, and in the following portion in four; its colour the reddest and strongest marking on the disk. The N. equatorial belt is shown as fainter and greyer, but generally of nearly the same breadth as the S. belt. The S. tropical zone and temperate band are shown in all the drawings, and the corresponding N. zone and band as well.

Messrs. Molesworth, Phillips, Killip, Townshend, Smart, Attkins, Anderson, Charles F. Smith, Hall, Ryle, Bolton, Foulkes, and the Director contribute to this section.

Section II., longitudes from 60° *to* 120°.—There are 13 drawings in this section, mostly comparable. The general features are shown generally as described in the previous section, but the N. equatorial belt is shown duplex in almost all the drawings, and diversified with a variety of light markings. The equatorial zone is generally shown yellow or reddish yellow, and Messrs. Anderson and Smith show the faint equatorial band.

Messrs. Attkins, Bridger, Anderson, Townshend, Ryle, Killip, and Smith contribute to this section.

Section III., longitudes 121° *to* 180°.—There are 10 drawings in this section, in most of which the S. equatorial belt is shown as duplex, and a large white spot, with, in some drawings, other smaller light markings on its northern edge. Mr. Attkins, in three of his drawings, shows the equatorial band, in two of them extending from limb to limb; and Mr. Phillips, on one of his drawings, shows it in the same way, and with a slight thickening at the preceding end. In this section the N. tropical band is shown as the broadest and lightest portion of the disk.

Messrs. Attkins, Bridger, Townshend, Hall, Phillips, Smith, Killip, and Ryle have sent drawings of this section.

Section IV., longitudes 181° *to* 240°.—There are 15 drawings of this section, all of them comparable. All show the S. equatorial belt duplex from limb to limb, and most show conspicuous white markings on its northern edge with dark spots between them, from which wisps cross the equatorial zone at various angles. The equatorial band is shown on only one drawing by Mr. Killip. And in this section, as in the last, the N. tropical band is a prominent feature.

Messrs. Attkins, Killip, Smith, Waugh, and Phillips contribute drawings of this section.

Section V., longitudes 241° *to* 300°.—There are 14 drawings of this section. The S. equatorial belt is shown duplex in all the drawings, with, as in the last section, light and dark spots on its northern edge and wisps from the latter. In eight of the drawings the equatorial band is distinctly shown on the reddish

equatorial zone. The N. equatorial belt is shown broad and diversified, with light spots and markings. The S. temperate band is shown on nearly all the drawings as duplex, and the S. temperate band broader and more distinct than in the preceding sections.

Messrs. Attkins, Townshend, Bolton, Killip, Phillips, Bridger, and Wright contribute to this section.

Section VI., longitudes 301° *to* 360°.—There are eight drawings of this section, six of which agree in showing a large and prominent white spot on the northern edge of the N. equatorial belt, and another, but less conspicuous, on the northern edge of the S. equatorial belt. In other respects the drawings are not easily comparable, and they show no other well-defined features.

Messrs. Bolton, Townshend, Attkins, Smith, and Wright contribute drawings of this section.

Capt. Molesworth has sent five drawings besides the two for the Album, which have been returned to him. They are in accordance with drawings by other Members of similar longitudes, and have not been included in the above descriptions.

Of the drawings received, 12 have been selected for reproduction in this Memoir. They have been chosen with a view to showing as far as possible the characteristics of the markings in each section described above.

It has been considered sufficient that the drawings reproduced should speak for themselves without giving a written description. The whole of the drawings can be referred to in the Album for 1898-99.

PART 3.

TRANSITS OF SPOTS, &C.

Capt. Molesworth and the Rev. T. E. R. Phillips have given special attention to the transits of dark and white spots on the disk, and their rotation periods.

Capt. Molesworth's notes and observations are very elaborate and complete, and are much too copious for entire reproduction. It is not at all an easy matter to do justice to his work in an abstract of it. He gives 38 folio pages of observations of 138 spots in 15 different belts and zones, extending from 31st May to 22nd September, followed by 44 pages of details of the various spots observed, and summaries and analyses of results.

The following is one of his tables showing the mean rotation periods deduced from his transit observations. His first column, giving the zones, has been omitted as he has a special method of lettering them, but the second column, giving approximate

latitude, and the column of "Description of Objects," will make the table sufficiently clear :—

MEAN ROTATION PERIOD OF SPOTS DEDUCED FROM TRANSIT OBSERVATIONS.

Approximate Latitude.	Number of Objects.	Description of Objects.	Average Drift.	Average Rotation Period.	Average Number of Transits.	Average Number of elapsed Rotations.
°			°	h m s		
−40	3	Dark spots in S. temperate belt.	−·3509	9 55 05·6	3·33	105
−33	5	White spots in S. temperate zone.	−·2493	9 55 15·87	3·40	109
−26	15	Dark spots and streaks in S. tropical belt.	−·2470	9 55 16·01	5·46	167
−8 to −15	4	Markings in neighbourhood of Red Spot Bay.	+·0176	9 55 41·98	14·25	248
− 8	5	White spots in centre of S. equatorial belt.	Not taken.	9 54 44·56	3·80	137
− 6	23	Dark spots in N. edge of S. equatorial belt.	*−·0523	9 50 24·85	7·30	204
− 5	19	White spots in S. edge of equatorial zone.	*−·0925	9 50 20·89	5·16	181
± 0	8	Dark spots and streaks in equatorial band.	*−·0006	9 50 29·94	3·39	159
+ 6	4	White spots in N. edge of equatorial zone.	*−·0032	9 50 29·68	4·25	128
+ 7	10	Dark spots at S. edge of N. equatorial belt.	−·2042	9 55 20·26	4·30	154
+10	10	Dark and white spots, centre of N. equatorial belt.	−·0565	9 55 35·01	5·00	183
+12	14	Dark spots at N. edge, N. equatorial belt.	−·1006	9 55 30·64	6·57	179
+12	7	White notches in N. edge, N. equatorial belt.	−·1947	9 55 31·22	6·86	155
+20	6	Dark streaks in N. tropical zone.	+·2598	9 56 06·41	4·50	123
+28	5	Dark streaks in N. temperate belt.	+·3718	9 56 17·54	4·40	173
Total -	138				5·70	170

The drifts marked thus * refer to Marth's System i., the rest to Marth's System ii.

This Table, Capt. Molesworth remarks, contains the gist of all the observations for longitude recorded in the book containing all these observations. Out of more than 1,100 recorded transits, nearly 800 (or about two thirds) have been utilised for the determination of the rotation periods of 138 spots, giving an average of 5·70 transits extending over 170 rotations of each spot.

The book also contains 20 diagrams giving graphical representations of the various tables.

In his remarks upon the currents of the S. equatorial belt, he says :—"There is a great difference in the periods of the currents "extending over the S. equatorial belt. This is accentuated "in the narrow isthmus between the Red Spot Bay and the "equatorial zone. At the centre of the bay the breadth of the "belt is narrowed down to almost nothing; but the N. edge of "this narrow portion has a period of $9^h\ 50^m\ 24^s{\cdot}8$, while the "S. edge has a period of $9^h\ 55^m\ 41^s{\cdot}9$.

"From the motion of the white spots in the centre of the "S. equatorial belt, I am inclined to adopt a mean period of "$\pm 9^h\ 54^m\ 44^s$ for these spots, which is intermediate between

"that of the Red Spot Bay and the spots in the N. edge of the "belt. I have traced these white spots right up to the following "shoulder, but have never seen them in the narrow isthmus "between the Red Spot Bay and the equatorial zone. They "would naturally be invisible in the bright double portion of the "belt preceding the Red Spot Bay, but can once more be traced "at the preceding end of the double portion. At this point the "more luminous centre of the belt seems to have a continuous "motion in a preceding direction. Presently a faint wisp moves "across near the preceding end, cutting off a circular white spot, "which rapidly increases its distance from the double portion, "and sets off down the centre of the belt as a separate spot.

"The question is, what becomes of these white spots when "their motion brings them to the following shoulder? They do "not, I think, pass *over* the shoulder; as I have never seen the "latter notched, as it would be, by the passage of a white spot. "They do not pass *round* the isthmus, or if they do they are "invisible during the passage. They cannot be absorbed, as "they re-appear at the other end of the double portion preceding "the red spot.

"The only alternative seems to be that these white spots pass "*under* the following shoulder, and probably under the Red Spot "itself. But this involves two very curious points:—First, the "existence of two absolutely distinct currents in the Jovian "atmosphere superimposed one on the other; and secondly, the "existence of a comparatively rapid current under the Red Spot, "which has hitherto been looked upon, from its permanence, as "the marking which is most likely to represent the actual motion "of the body of the planet. The question is a most interesting one, "and the motion of these spots should be most carefully studied."

Captain Molesworth discusses the question of the relative levels of the various markings, and states his impression that the darker markings are at a relatively higher level than the light ones. He concludes, "A careful consideration of the equatorial zone and "equatorial band tends to confirm the impression that the darker "markings are at a relatively higher level. The delicate wisps "would be very difficult to explain if the contrary was the case, "and the rapid changes in their inclination to the equatorial "belts would imply enormous movements in the brighter matter "of the equatorial zone."

As regards the Great Red Spot, Captain Molesworth remarks that it is very faint indeed, but still visible. It appears as the faintest possible grey stain with no trace of red. A consideration of the longitude observations seems to show that the breadth of the Red Spot Bay from shoulder to shoulder has decidedly increased. He has taken observations of the longitudes of three points PS the preceding shoulder, RS the centre at the northern edge of the Red Spot Bay, and FS the following shoulder.

The longitudes of these three spots at various periods are given as follows:—

	PS	RS	FS
	°	°	°
June 1898 - -	5	25	42
June 1899 - -	19·5	36·5	55
September 1899 -	19·5	39	62

The width of the bay was, therefore, 37·0° in June 1898; 35·5° in June 1899; but had increased to 42·5° in September 1899.

Comparing the results of the 1899 observations with those of the previous year, the mean rotation periods of the three points come out as follows :—

Spot.	Inclusive Dates.	Shift in Longitude.	Number of Rotations.	Mean Rotation Period.
		°		h m s
PS	April 4, 1898, to September 17, 1899.	13·62	1286	9 55 41·68
RS	April 2, 1898, to September 22, 1899.	18·73	1300	9 55 42·05
FS	March 26, 1898, to September 22, 1899.	20·90	1317	9 55 42·21

From this it will be seen that the motion of RS, which he thinks fairly represents that of the Great Red Spot, has practically remained constant since April 1898, its period being almost exactly $9^h\ 55^m\ 42^s{\cdot}0$.

The Rev. T. E. R. Phillips, of Yeovil, whose observations of transits of spots are next to Captain Molesworth's—the most numerous,—has arrived at the same rotation period for the Great Red Spot.

The following is the summary of his observations which he has furnished.

ROTATION PERIOD OF THE RED SPOT IN 1899.

A considerable number of transits of this remarkable object, and of the well-known hollow in the S. equatorial belt were secured between the beginning of January and the early part of August.

The mean period worked out as—

$$9^h\ 55^m\ 42^s{\cdot}1,$$

but the rate of motion was perceptibly quicker than this during the early part of the apparition. The acceleration of velocity, doubtless, commenced during the autumn of 1898, as at the beginning of January 1899 the longitude of the spot was about 4° less than that computed according to its rate of motion during the previous apparition.

The increased velocity thus indicated was maintained at the beginning of 1899, the rotation period at this time differing but slightly from that of the zero meridian of System II. (Mr. Crommelin's Ephemeris).

ROTATION PERIOD OF THE GREAT EQUATORIAL CURRENT IN 1899.

An immense amount of detail was visible in the equatorial regions of the planet during the apparition of 1899, and numerous observations were made at Yeovil with the object of determining the present velocity of the surface material in this latitude.

Thirty-four spots at or close to the N. edge of S. equatorial belt, and 21 at the S. edge of the N. equatorial belt (which had greatly developed since the appariton of 1898) were sufficiently well observed to enable their rotation periods to be deduced. In a few instances the matter of correct identification of S. equatorial spots presented some difficulty, as the spots at times were very erratic in their movements, but it is believed that the mean results arrived at are to be relied on as being very near the truth.

—	Number of Spots observed.	Rotation Period.
		h m s
Spots at N. edge of S. equatorial belt -	34	9 50 24·66
Spots at S. edge of N. equatorial belt -	21	9 50 26·22
The corresponding values in 1898 were :—		
Spots at N. edge of S. equatorial belt -	19	9 50 24·2
Spots at S. edge of N. equatorial belt -	3	9 50 24·5

The following is a table of the individual spots observed during the apparition of 1899.

W = white spot. D = dark spot.

SPOTS AT N. EDGE OF S. EQUATORIAL BELT.

No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
1	W.	194	359	9 50 24·7	17 observations. Motion erratic.
2	D.	139	9	9 50 24·8	10 observations.
3	W.	132	18	9 50 22·8	Only 6 observations, but identity pretty certain.
4	D.	203	27	9 50 20·9	8 observations.
5	W.	203	33	9 50 21·5	11 observations.
6	D.	110	46	9 50 22·9	7 observations.
7	W.	69	—	9 50 22·0	Spot apparently not formed till middle of May.
8	D.	182	52	9 50 25·7	11 observations.
9	W.	182	74	9 50 26·2	15 observations.
10	D.	90	89	9 50 28·1	14 observations.
11	W.	55	98	9 50 26 7	6 observations.
12	D.	55	109	9 50 27·2	Few observations, but identification certain.
13	W.	162	120	9 50 24·3	12 observations.
14	D.	194	131	9 50 25·3	13 observations.
15	W.	194	140	9 50 26·2	7 observations.
16	D.	96	148	9 50 30·4	Not seen till beginning of May.

No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
17	W.	164	155	9 50 29·7	Not very well observed.
18	D.	219	170	9 50 29·6	13 observations.
19	W.	109	—	9 50 25·9	Not seen after end of April.
20	D.	79	—	9 50 31·8	Not seen after end of March.
21	W.	107	198	9 50 24·0	Few observations. Spot vague and faint.
22	D.	111	208	9 50 27·4	7 observations.
23	W.	194	221	9 50 23·1	14 observations.
24	D.	212	230	9 50 22·8	27 observations.
25	W.	173	243	9 50 22·8	22 observations.
26	D.	85	255	9 50 19·2	9 observations.
27	W.	97	265	9 50 18·6	10 observations.
28	D.	173	274	9 50 25·1	23 observations.
29	W.	139	290	9 50 23·3	21 observations. Exceedingly brilliant, especially about April 10.
30	D.	111	301	9 50 21·6	21 observations.
31	W.	111	319	9 50 19·2	17 observations.
32	D.	187	330	9 50 25·2	16 observations.
33	W.	48	342	9 50 23·0	6 observations.*
34	D.	47	349	9 50 26·1	5 observations.*

* These spots apparently developed at the end of April.

SPOTS AT S. EDGE OF N. EQUATORIAL BELT.

1	D.	116	346	9 50 20·4	7 observations.
2	W.	60	8	9 50 30·4	Few observations, but identity certain.
3	D.	30	—	9 50 17·2	Not observed till May 22nd.
4	W.	71	36	9 50 33·4	Only 3 observations.
5	D.	64	57	9 50 29·1	8 observations.
6	W.	69	69	9 50 29·1	6 observations.
7	D.	74	80	9 50 28·9	5 observations.
8	W.	70	99	9 50 21·4	9 observations. Bright.
9	D.	69	111	9 50 28·6	7 observations.
10	D.	53	150	9 50 26·9	Only 4 observations.
11	D.	60	182	9 50 22·4	5 observations.
12	W.	55	194	9 50 24·7	7 observations.
13	D.	68	203	9 50 24·7	Only 4 observations.
14	D.	90	214	9 50 24·4	6 observations.
15	D.	70	230	9 50 24·8	Only 3 observations, but identification pretty certain.
16	W.	64	248	9 50 27·3	9 observations.
17	D.	171	262	9 50 26·0	11 observations. Very dark.
18	W	44	274	9 50 23·7	6 observations.
19	D.	95	295	9 50 31·4	10 observations.
20	W.	68	312	9 50 30·8	6 observations.
21	D.	30	324	9 50 25·2	Only 3 observations.

Mr. Walter J. Hall, of Nantwich, has furnished the following Tables of Spot Transits observed by him :—

1899.

SPOT TRANSIT, TABLE NO. 1.

The "Bay" of the Great Red Spot.

Date.	G.M.T.	Wt.	λ System II.	Remarks.
	h m		°	
Apr. 17 -	10 12	1	50·0	*f* end of "bay."
May 4 -	8 47	1	35·4	Middle „
„ 4 -	9 13	2	51·1	*f* end „
„ 6 -	9 56	1	17·8	*p* end „
„ 6 -	10 19	est.	31·7	Middle „
„ 6 -	10 50	1	50·4	*f* end „
„ 11 -	9 58	est.	50·9	*f* end „
„ 18 -	9 45	est.	15·4	*p* end „
„ 18 -	10 45	est.	51·7	*f* end „
„ 23 -	9 2	1	21·2	*p* end „
„ 23 -	9 24	est.	34·5	Middle „
„ 23 -	9 48	1	49·0	*f* end „
„ 30 -	10 12	est.	35·6	Middle „
„ 30 -	10 37	1	50·7	*f* end „
June 6 -	10 28	1	17·2	*p* end „
„ 16 -	9 40	1	50·7	*f* end „

Rotation Period, $9^h\ 55^m\ 40^s{\cdot}6$. No change in rate.

1899.

SPOT TRANSIT, TABLE NO. 2.

Light Spot overlying S. Equatorial Belt.

May 6 -	9 26	1	0·3	Very prominent overlying white spot.
„ 6 -	9 33	1	4·5	*f* end of same.
June 6 -	10 0	est.	0·3	

Rotation Period, normal, viz., $9^h\ 55^m\ 40^s{\cdot}6$.

1899.

SPOT TRANSIT, TABLE No. 3.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m			
Apr. 22 -	12 13	1	6°5	A prominent indentation in equatorial zone.
May 22 -	10 30	est.	3·6	
„ 29 -	9 57	1	9·1	
„ 31 -	11 10	1	9·4	Dark rift seen from this spot across the equatorial zone to spot No. 4.

Rotation Period, $9^h\ 50^m\ 33^s\cdot1$.

1899.

SPOT TRANSIT, TABLE No. 4.

Dark Spot on S. Side of N. Equatorial Belt.

May 31 -	11 30	est.	21·6	A rift from this spot crosses the equatorial zone to spot No. 3.
June 5 -	9 35	est.	21·0	

Rotation Period, $9^h\ 50^m\ 25^s\cdot1$.

1899.

SPOT TRANSIT, TABLE No. 5.

Dark Spot on N. Side of S. Equatorial Zone.

Mar. 18 -	12 20	1	239·3
May 3 -	10 21	est.	236·1

Rotation Period, $9^h\ 50^m\ 27^s\cdot2$.

4. 1899.

SPOT TRANSIT, TABLE NO. 6.

Dark Spot on S. Side of N. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
Mar. 18 -	13 0	1	263·7	
Apr. 17 -	11 17	1	261·8	

Rotation Period, $9^h\ 50^m\ 27^s\cdot5$.

4. 1899.

SPOT TRANSIT, TABLE NO. 7.

Dark Spot on N. Side of S. Equatorial Belt.

May 3 -	11 21	2	272·7	
June 2 -	9 35	est.	267·1	

Rotation Period, $9^h\ 50^m\ 22^s\cdot5$.

4. 1899.

SPOT TRANSIT, TABLE NO. 8.

Light Spot on N. Side of S. Equatorial Belt.

Apr. 22 -	10 22	1	298·2	Large white spot.
May 3 -	11 31	1	278·7	*p* end.
„ 3 -	11 52	1	291·6	Middle.
„ 3 -	12 10	1	302·5	*f* end.
„ 31 -	8 50	est.	283·7	
June 2 -	9 55	est.	279·2	

Rotation Period, $9^h\ 50^m\ 12^s\cdot7$.

1899.

SPOT TRANSIT, TABLE No. 9.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
May 6 -	9 5	1	303·8	
„ 31 -	9 8	est.	294·7	Dark rift n.f. to N. equatorial belt.

Rotation Period, $9^h\ 50^m\ 15^s\cdot4$.

1899.

SPOT TRANSIT, TABLE No. 10.

Dark Spot on S. Side of N. Equatorial Belt.

Feb. 11 -	19 22	—	7·6	T. E. R Phillips in "E.M.," May 5, p. 267.
Mar. 20 -	16 45	—	357·2	
Apr. 22 -	11 46	1	349·5	
May 6 -	10 8	1	342·2	

Rotation Period, $9^h\ 50^m\ 18^s\cdot2$.

1899.

SPOT TRANSIT, TABLE No. 11.

Light Spot on S. Side of Equatorial Zone.

Apr. 22 -	11 53	1	354·0	
June 14 -	9 4	1	343·2	

Rotation Period, $9^h\ 50^m\ 21^s\cdot6$.

1899.

SPOT TRANSIT, TABLE No. 12.

Light Spot on Equatorial Zone.

Apr. 22 -	12 1	1	359·2	
May 22 -	10 15	1	354·6	Large white spot extending threequarters the way across the zone.

Rotation Period, $9^h\ 50^m\ 23^s\cdot8$.

1899.

SUMMARY OF ROTATION PERIODS OF SPOTS.

Spot No.	Kind.	Rots.	h	m	s
1	G.R.S. "Bay"	145	9	55	40·6
2	Light	75	9	55	40·6

Equatorial Current.

3	Dark	95	9	50	33·1
4	,,	12	9	50	25·1
5	,,	112	9	50	27·2
6	,,	73	9	50	27·5
7	,,	73	9	50	22·5
8	Light	100	9	50	12·7
9	Dark	61	9	50	15·4
10	,,	204	9	50	18·2
11	Light	129	9	50	21·6
12	,,	73	9	50	23·8

Mean for the Equatorial Current, $9^h\ 50^m\ 22^s{\cdot}7$.

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Nantwich.

WALTER J. HALL.

The attention of the Members of the Section is directed to two papers that have recently been printed in the "Monthly Notices" of the Royal Astronomical Society; one by the Rev. T. E. R. Phillips on "The Equatorial Currents of Jupiter in 1899," Vol XL., p. 210, and the other by Mr. G. W. Hough, Director of the Dearborn Observatory, Evanston, U.S.A., "Observations on the Spots and Markings on the Planet Jupiter," made at that Observatory, Vol. XL., p. 546. This paper relates to observations made during a period of 20 years, and Mr. Hough's "Conclusions" at the end of the paper deserve careful study.

PART 4.

SATELLITE OBSERVATIONS.

The satellite observations are less numerous than usual, probably owing to the unfavourable position of the planet. None have been received from observers at the Antipodes, whose opportunities have probably been greater than ours. The fullest returns are those of Capt. Molesworth, whose station in the clear air of Ceylon, and whose large telescope, have enabled him to do some excellent work in this department as usual. Two other observers have sent statements—the Rev. Theodore E. R. Phillips, Yeovil, and Mr. J. H. Bridger, Farnborough.

The following tabular statement combines the observations of the three, and the observations of each are distinguished by the initial letters M., P., and B. respectively.

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Apr. 4	II. Tr. E.	External contact.	13 53 0	13 54 0	P.	
Apr. 21	I. Sh. I.	First seen	11 5 0	11 7 0	P.	
—	—	External contact.	11 11 0	11 13 0	P.	
May 6	II. Tr. I.	Do.	9 43 0	9 42 0	P.	
May 7	I. Tr. I.	Do.	9 5 30	9 7 0	P.	
—	—	Bisection	9 8 30	—	P.	
—	—	Internal contact.	9 12 0	—	P.	
—	I. Tr. E.	Do.	11 12 0	—	P.	
—	—	Bisection	11 16 0	—	P.	
—	—	External contact.	11 19 0	11 18 0	P.	Invisible after $11^h\ 34^m$ through blurring of the image.
May 22	I. Oc. D.	First contact.	9 51 0	—	P.	
—	—	Disappeared.	9 53 30	9 52 0	P.	
May 23	I. Tr. E.	External contact.	9 16 30	9 16 0	P.	
May 29	II. Oc. D.	First contact.	11 0 30	—	P.	
—	—	Disappeared.	11 4 30	11 2 0	P.	
—	I. Oc. D.	First contact.	11 36 0	—	P.	
—	—	Disappeared.	11 40 0	11 36 0	P.	
May 30	I. Tr. E.	Internal contact.	10 56 0	—	P.	
—	—	Bisection	11 0 0	—	P.	
—	—	Just clear	11 3 0	11 3 0	P.	
May 31	III. Ec. R.	Just glimpsed.	10 0 0	10 2 55	P.	
—	III. Ec. R.	Glimpsed	10 0 45	—	B.	
—	—	Bright	10 5 55	—	B.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
June 2	II. Ec. R.	First glimpse.	4 7 44	4 10 0	M.	
—	—	Fully bright.	4 9 54	—	M.	
June 7	II. Tr. E.	Internal contact.	10 12 0	—	P.	
—	—	Just clear	10 19 30	10 12 0	P.	
—	III. Oc. R.	First seen	10 25 0	10 27 0	P.	
—	—	Just clear	10 34 0	—	P.	
—	I. Ec. R.	Just seen	10 55 0	10 55 14	P.	
—	II. Sh.	On disk	—	—	P.	Dark grey, not black.
June 8	I. Tr. I.	First contact.	5 3 36	5 6 0	M.	
—	—	Last contact.	5 7 36			
—	—	On disk	5 9 21	—	M.	Fading.
—	—	Do.	5 17 36	—	M.	Elongated.
—	—	Do.	5 20 21	—	M.	No longer visible.
June 8	I. Sh. I.	First contact.	6 0 51	6 2 0	M.	
—	—	Last contact.	6 4 6			
June 9	I. Oc. D.	First contact.	2 17 29	2 18 0	M.	
—	—	Gone	2 19 24			
—	II. Oc. D.	First contact.	2 30 44	2 35 0	M.	
—	—	Gone	2 35 44			
—	I. Ec. R.	First glimpse.	5 23 9	5 23 49	M.	
—	—	Fully bright.	5 25 14	—	M.	
June 14	I. Oc. D.	First contact.	9 37 0	—	P.	
—	—	Disappeared.	9 42 0	9 39 0	P.	
—	II. Tr. I.	External contact.	10 19 0	10 15 0	P.	
—	—	Bisection	10 22 30	—	P.	
—	—	Internal contact.	10 27 0	—	P.	
June 15	I. Tr. E.	Do.	9 2 0	—	P.	
—	—	Bisection	9 5 0	—	P.	
—	—	External contact.	9 8 0	9 7 0	P.	
—	I. Sh. E.	Internal contact.	10 0 0	—	P.	Shadow very black and sharply defined.
—	—	Just gone	10 7 0	10 8 0	P.	
June 16	I. Oc. D.	First contact.	4 5 3	4 6 0	M.	
—	—	Gone	4 8 53			
—	II. Oc. D.	First contact.	4 55 48	5 0 0	M.	Optical flattening of limb just before first contact.
—	—	Gone	5 1 28		M.	
June 17	I. Tr. I.	First contact.	1 19 39	1 22 0	M.	
—	—	Last contact.	1 23 26			
—	I. Sh. I.	First contact.	2 24 59	2 25 0	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
			h m s	h m s		
1899. June 18	II. Sh. Tr.	On Central Meridian.	2 39 24	—	M.	
—	III. Tr. I.	Just inside disk.	2 18 24	—	M.	Very luminous.
—	III. Tr. E.	After first contact.	3 39 24	3 45 0	M.	
—	—	Last contact.	3 52 24			
—	III. after Tr.	On sky	4 25 0	—	M.	Very faint; fainter than II. or I.
—	—	Do.	5 1 0	—	M.	Now decidedly brighter than II.
June 21	I. Oc. D.	Dis appeared.	11 30 0	11 28 0	P.	
June 23	I. Oc. D.	First contact.	5 54 37	5 56 0	M.	
—	—	Gone	6 1 6			
June 25	II. Tr. I.	First contact.	1 54 13	1 51 0	M.	
—	—	Last contact.	1 59 13			
—	II. Tr. E.	First contact.	4 11 3	4 11 0	M.	
—	—	Last contact.	4 16 28			
—	II. Sh. I.	Do.	4 15 53	4 11 0	M.	
—	—	On Central Meridian.	5 9 48	—	M.	
—	III. Tr. I.	First contact.	5 18 53	5 32 0	M.	
—	—	Last contact.	5 38 43			
June 27	II. Ec. R.	First glimpse.	1 18 44	1 21 19	M.	
—	—	Fully bright.	1 22 24	—	M.	
June 29	III. Ec. R.	First glimpse.	1 55 21	1 56 39	M.	
July 2	I. Oc. D.	First contact.	2 13 53	2 14 0	M.	
—	—	Gone	2 17 23			
—	II. Tr. I.	First contact.	4 20 43	4 18 0	M.	
—	—	Last contact.	4 24 3			
—	I. Ec. R.	First glimpse.	5 34 52	5 36 0	M.	
—	—	Fully bright.	5 37 43	—	M.	
July 3	I. Tr. E.	First contact.	1 40 26	1 44 0	M.	
—	—	Last contact.	1 44 1			
—	I. Sh.	On C.M.	1 40 46	—	M.	
July 4	II. Oc. R.	Half off	1 31 30	1 33 0	M.	Not quite bisected.
—	—	Clear	1 36 30		M.	
—	II. Ec. D.	Fading	1 37 50	—	M.	
—	—	Gone	1 43 30	1 43 22	M.	
—	II. Ec. R.	First glimpse.	3 57 30	3 58 41	M.	
—	—	Fully bright.	4 1 0	—	M.	
July 6	III. Oc. R.	Clear	1 16 43	1 14 0	M.	
—	III. Ec. D.	Fading	4 18 28	—	M.	
—	—	Still circular.	4 19 58	—	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
July 6	III. Oc. D.	Gone	4 33 54	4 27 33	M.	
—	III. Ec. R.	First glimpse.	5 51 18	5 55 4	M.	
—	—	Fully bright.	—	—	M.	Not noted. Clouds.
July 8	I. Tr. E.	First contact.	9 7 53	—	B.	Unsteady.
—	—	Bisected	9 9 33	—	B.	
—	—	Last contact.	9 11 26	—	B.	
July 9	I. Oc. D.	First contact.	4 1 44	4 6 0	M.	
—	—	Gone	—		M.	Not noted. Clouds.
July 10	II. Tr. I.	First contact.	1 23 42	1 24 0	M.	
—	—	Last contact.	1 26 59			
July 11	II. Oc. D.	First contact.	1 40 1	1 44 0	M.	
—	—	Gone	1 46 16			
July 13	III. Ec. R.	Glimpsed	9 53 50	—	B.	
—	—	Bright	10 0 19	—	B.	
July 16	II. Tr. I.	External contact.	9 18 8	—	B.	Fairly steady.
—	—	Bisected	9 19 19	—	B.	Twilight.
—	—	Internal contact.	9 21 3	—	B.	
—	I. Ec. R.	Glimpsed	9 25 26	—	B.	
—	—	Bright	9 27 3	—	B.	
July 18	I. Ec. R.	First glimpse.	3 53 44	3 54 3	M.	
—	—	Fully bright.	3 56 24	—	M.	
—	II. Oc. D.	First contact.	4 16 14	4 19 0	M.	Disappearance.
—	—	Gone	4 20 14	—	M.	Perfectly regular.
—	II. Ec. R.	Glimpsed	9 11 49	—	B.	
—	—	Bright	9 14 3	—	B.	
July 25	II. Oc. R.	Glimpsed	9 17 23	—	B.	
—	—	External contact.	9 20 35	—	B.	
Aug. 1	I. Oc. D.	First contact.	4 16 39	4 18 0	M.	
—	—	Gone	4 20 14			
Aug. 2	I. Tr. I.	First contact.	1 35 19	1 37 0	M.	
—	—	Last contact.	1 38 14			
—	On disk	Elongation E.W. suspected.	1 45 0	—	M.	
—	—	Elongation certain.	2 4 0	—	M.	
—	—	Still bright.	2 14 0	—	M.	
—	I. Tr. E.	First contact.	3 48 54	3 50 0	M.	
—	—	Last contact.	3 51 59			
—	I. Sh.	On C.M.	3 47 39	—	M.	No penumbra. Circular and black.
—	IV. on sky	Near conjunction.	1 35 0	—	M.	Very faint.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Aug. 3	I. Ec. E.	First glimpse.	2 11 44	2 12 14	M.	
—	—	Elongated N.S.	2 12 52	—	M.	
—	—	Fully bright.	2 14 24	—	M.	
—	II. Tr. I.	Well on	4 0 0	—	M.	Very luminous.
Aug. 5	II. Ec. D.	Already faint.	1 29 48	—	M.	
—	—	Gone	1 31 53	1 30 17	M.	
Aug. 10	IV. near	Conjunction	1 35 0 to 2 20 0	—	M.	Very faint, and with a strong blue tinge.
Aug. 11	III. Ec. R.	First glimpse.	1 47 52	1 49 44	M.	
—	—	Fully bright.	2 4 21	—	M.	
Aug. 12	II. Oc. D.	First contact.	1 31 49	1 34 0	M.	
—	—	Gone	1 36 29			
Aug. 27	IV. past	Conjunction	1 5 0 to 2 5 0	—	M.	Faint and blue.
Aug. 28	II. Tr. I.	First contact.	1 10 52	1 10 0	M.	
—	—	On	1 16 47			
Sept. 2	I. Oc. D.	First contact.	—	1 7 0	M.	Missed.
—	—	Gone	1 8 45		M.	
Sept. 3	I. Tr. E.	First contact.	—	0 41 0	M.	Missed.
—	—	Last contact.	0 44 13		M.	
—	I. Sh.	On disk	0 55 0	—	M.	Some distance past C.M., sharp and black.
Sept. 12	III. Tr. I.	First contact.	1 52 59	2 4 0	M.	
Sept. 13	II. Oc. D.	Do.	1 51 17	1 54 0	M.	
—	—	Gone	1 56 12			
Sept. 22	II. Tr.	On disk	1 8 8	—	M.	
—	II. Tr. E.	First contact.	—	1 16 0	M.	Missed in a wisp of cloud.
—	—	Clear	1 18 53		M.	Doubtful, definition tremulous.

PART 5.

The Director requested several of the Members of the Section to note the colours and colour changes during the apparition, and some of the notes furnished by the observers are as follows :—

Mr. Townshend, 1899, *April* 30, $11^h\ 10^m$ λ 240°.—Both great belts brown smoke colour; equatorial zone pale pink. Both poles bluish.

May 3, $9^h\ 20^m$ λ 265°.—S. equatorial belt dark mahogany colour, with a bright rift throughout; N. equatorial belt narrow and greenish yellow tint. Equatorial zone ruddy, especially the

southern section, and gradually fading away into the N. belt, showing no dividing line. Fine equatorial belt grey. S. tropical belt divided from end to end and grey. S. temparate belt same as S. tropical belt. Both poles grey.

May 6, $10^h\ 45^m$ λ 47°.—S. equatorial belt sepia. Following shoulder of bay heaped up to a peak, like a mountain peak, and high. N. equatorial belt pale green and flocculent. Outline of Great Red Spot glimpsed, with greyish centre. Equatorial zone salmon pink, and to the N. melting into the greenish N. belt.

May 26, $11^h\ 5^m$ λ 186°.—Both great belts drab, southern the heaviest. Equatorial zone yellowish. Rifts in belts partake of the general tone of colour, but luminously so.

May 28, 11^h λ 123°.—S. equatorial belt dull olive green; N. equatorial belt dull pale sage green, with horizontal wavy markinge. Equatorial zone pink in centre only, fading into colourless limbs. N. pole heavy grey. An hour previously the equatorial zone was yellow.

June 4, $9^h\ 20^m$ λ 35°.—S. equatorial belt dark slate blue. N. equatorial belt same colour, but less pronounced. Equatorial zone ruddy. Fine equatorial belt seen all the way across the disk, pale grey. At $9^h\ 47^m$ the equatorial zone suddenly changed to a yellow tint, and at $10^h\ 10^m$ it as suddenly changed to a pink tint, and both belts to a mahogany colour. (Mr. Townshend notes that these changes were corroborated by a friend who was with him.)

June 5, 11^h λ 246°.—N. and S. equatorial belts smoky green colour, fading away towards limbs. Equatorial zone pale yellow; fine equatorial belt seen centrally only.

June 6, $9^h\ 25^m$ λ 339°.—S. and N. equatorial belts dull grey; equatorial zone faintly ruddy orange, fading away towards limbs.

June 15, $10^h\ 15^m$ λ 281°.—S. equatorial belt dull pale green, with a luminous pale greenish rift from end to end, and a loop formation centrally of the same colour. N. equatorial belt pale green, with a luminous greenish narrow rift from end to end. Equatorial zone pale yellow. N. pole faintly green.

The pink or ruddy appearance of the equatorial zone remains singularly marked in the region of the Great Red Spot, while the opposite side of the planet assumes uniformly quiescent colours. Mr. Townsend considers the changing colours of the equatorial zone and belts to be due to incandescent vapours of metals.

The Rev. Theodore E. R. Phillips, 1898, *December* 21.—Both equatorial belts reddish chocolate, but the southern belt decidedly the darker of the two. Equatorial zone yellowish orange.

1899, *January* 16.—Both equatorial belts reddish chocolate, other belts grey.

February 27, *March* 20 *and* 22.—Equatorial belts reddish chocolate. Equatorial zone orange.

March 27.—Both equatorial belts a brown red.

April 4.—Belts less strongly coloured, but still reddish.

April 15.—Equatorial belts reddish chocolate.

April 18.—S. equatorial belt decidedly red. N. equatorial belt a slight tinge of purple.

April 19.—S. equatorial belt red. N. equatorial belt very grey without a trace of red.

April 22.—S. equatorial belt of a very deep chocolate red. N. equatorial belt greyish blue.

May 6.—Both belts reddish.

May 23.—S. equatorial belt deep purplish red. N. equatorial belt grey with a tinge of green. Other belts grey. Equatorial zone yellowish orange.

June 3.—S. equatorial belt deep purplish red. N. equatorial belt much greyer, but with a tinge of red.

June 4.—S. equatorial belt very deep purplish red. N. equatorial belt greyish, but with a decided tinge of red. Other belts grey.

Mr. Phillips remarks that observers seem to vary much in their estimation of colour, and some are much more capable of appreciating variations in tint than others. He instances that Mr. Stanley Williams speaks of seeing various features "as all red" which to his eye are all distinctly grey.

The Rev. Robert Killip, 1899, *May* 19.—The N. equatorial belt is still decidedly green to my eye, as is the portion of the S. equatorial belt preceding the hollow beneath the great shoulder.

June 9.—I always see the difference between the N. and the S. equatorial belts. The shade of the former is dirtier, if I may so say, still the greenish nature of it is there.

Mr. Killip adds,—The colour of the N. equatorial belt—though not very marked in the earlier months—was decidedly and always green to my eye later on. The equatorial zone was never without a tinge of orange; while the S. equatorial belt from first to last was of a chocolate hue.

Mr. Ernest Attkins.—S. polar region. Usually of a browny red colour and rather dense.

S. temperate zone. Noted on nine nights as white, and on 26 as yellowish.

S. tropical band corresponded in colour with the S. equatorial belt.

S. tropical zone always brilliantly white.

S. equatorial belt. Almost always duplex, of a marked red tint, which afterwards changed to a golden brown tone. Always darker and denser than the N. equatorial belt.

Great Red Spot. The bay usually perfectly white, the spot itself either a very faint grey or very slightly warm in tone, especially on May 23.

Equatorial zone a most beautiful yellow colour.

Equatorial band seen on a few nights, but generally faint.

N. equatorial belt. On the whole about equal in width to the S. equatorial belt, fainter, but always of the same colour

N. tropical zone. Generally white, but occasionally yellowish,

N. temperate band. Seen on several nights. Usually it partook of the tint of the N. polar region.

N. polar region. On some nights its blue tint was very striking, but it was not always blue. On May 29 and June 16 it was noted as being distinctly brownish red. Very often more grey than blue.

The changes of colour deserve careful and systematic observation.

ARTHUR COTTAM,
Director of the Section.

July 13, 1900.
Watford, Herts.

OBSERVATIONS OF JUPITER, 1899.

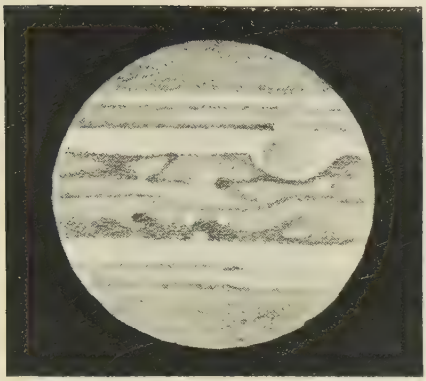

Fig. 1. P. B. Molesworth, 12½ in. Spec.
1899, June 7, 5 h. 57 m. Long. 5°.

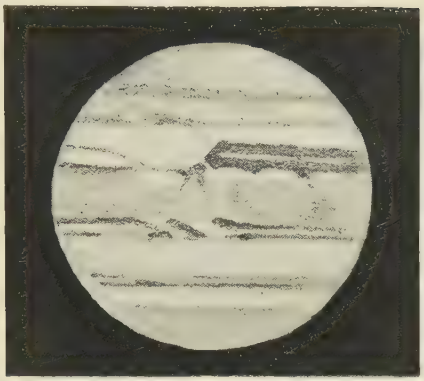

Fig. 2. T. E. R. Phillips, 9 in. Spec.
1899, April 19, 11 h. 50 m. Long. 50.1°.

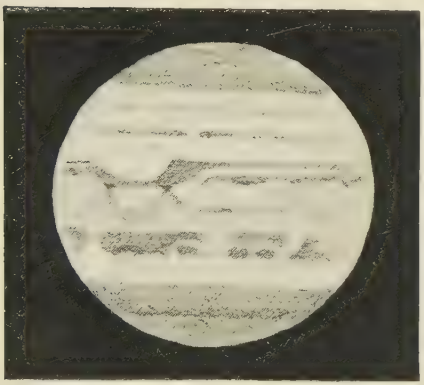

Fig. 3. Scriven Bolton, 4½ in. O.G.
1899, June 16, 9 h. 45 m. Long. 54°.

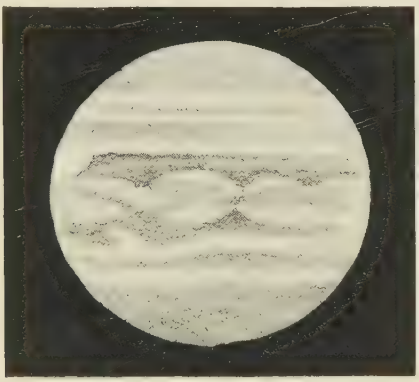

Fig. 4. W. Anderson, 5 in. O.G.
1899, May 9, 9 h. 20 m. Long. 87°.

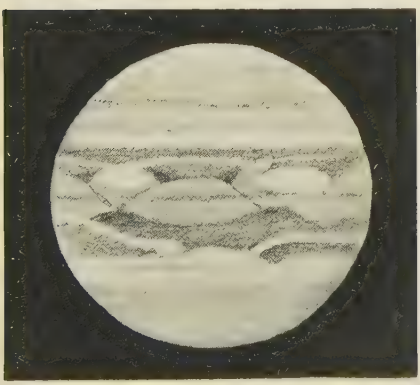

Fig. 5. E. Attkins, 6½ in. Spec.
1899, April 17, 13 h. 2 m. Long. 153°.

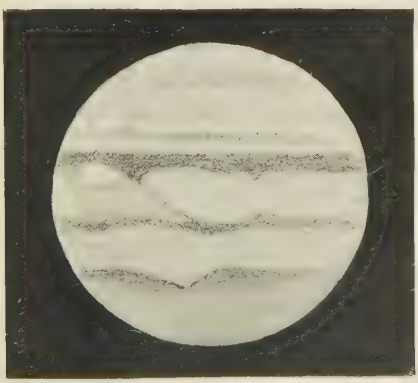

Fig. 6. W. J. Hall, 4⅞ in. Spec.
1899, May 31, 9 h. 30 m. Long. 161°.

OBSERVATIONS OF JUPITER, 1899.

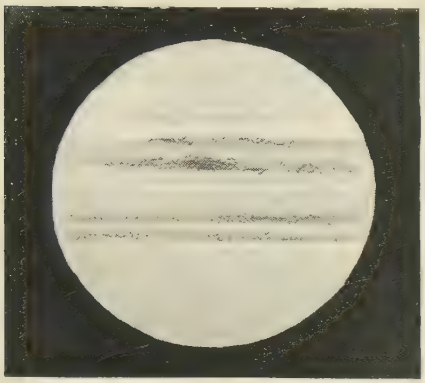

Fig. 7. W. R. Waugh, 4½ in. O.G.
1899, June 16, 10 h. Long. 220°.

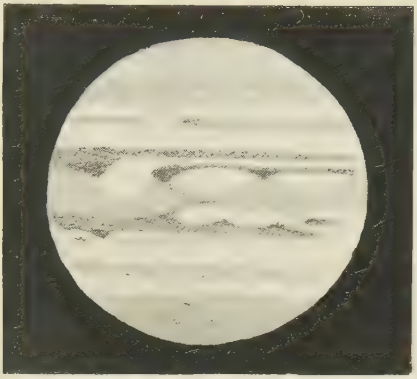

Fig. 8. T. E. R. Phillips, 9 in. Spec.
1899, March 22, 14 h. 5 m. Long. 238°.

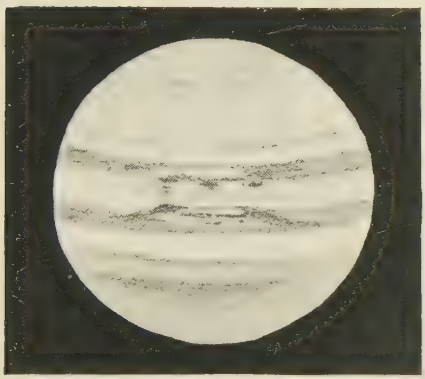

Fig. 9. H. J. Townshend, 10 in. Spec.
1899, June 5, 11 h. Long. 246°.

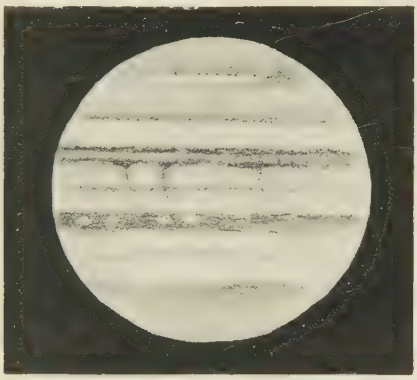

Fig. 10. Robert Killip, 5 in. O.G.
1899, June 3, 9 h. 45 m. Long. 260°.

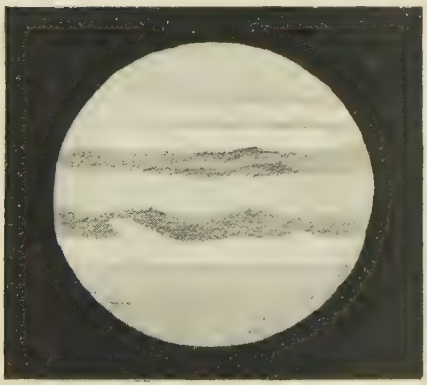

Fig. 11. J. H. Bridger, 4 in. O.G.
1899, May 27, 10 h. 5 m. Long. 300.5°.

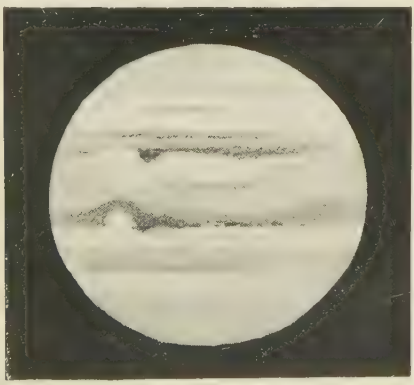

Fig. 12. Charles F. Smith, 5¼ in. Spec.
1899, June 13, 10 h. 25 m. Long. 348°.

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